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INTERNATIONAL FISHERIES EXHIBITION.

"THIS exhibition was opened on the 20th of May, by the Crown Prince of Prussia and Germany, in the Agricultural Museum at Berlin, of which we give an illustration. It is very extensive and various, both as regards the interesting collection of living fish, and that of many descriptions of fishing tackle, which have been gathered from all parts of the world, and the great variety of smoked, preserved, and tinned fish. China, Japan, Holland, Germany, America, England, Russia, Italy, Denmark, Norway, Sweden, and Austria-Hungary, are all more or less represented. It is, in fact, as the Commissioner of the United States remarked, 'a union of all nations of the earth in a comparative and competitive display of the wealth of their rivers, lakes, and seas, and the ingenuity with which the inhabitants of the waters are laid under contribution to furnish food, clothing, and ornament for mankind.' It must be confessed, however," says the *Illustrated London News*, "that the British department is quite inadequate; there is no attempt, indeed, to represent the immense marine fisheries belonging to this country. Mr. Frank Buckland has contributed a series of casts and photographs of salmon and various river fish, some of which will be quite new to the majority of German visitors. Messrs. Bartlett & Sons, of Redditch, furnish the only large case which the British department contains. This is full of a great variety of hooks and fishing tackle. Messrs. MacCombie & Co., of Peterhead, Scotland, have sent a very neatly made model showing the mode in which herrings are salted and packed ready for export. Mr. De Cant, of Great Yarmouth, exhibits a new deep-sea trawling net, which appears to possess certain advantages over the present system. He has also a crab and lobster trap, which is so constructed as to allow under-sized fish to escape. With the exception of these, there is very little of interest in the British portion; in fact, almost our whole show is contained in a room some twenty-five feet square, which is about one-fourth of the space that was allotted to us."

The American display is very fine, the largest of any foreign nation, and attracts great attention.

THE AGRICULTURAL MUSEUM, BERLIN, WHERE THE INTERNATIONAL FISHERIES EXHIBITION IS HELD.

A GREAT LEAD PILE.

THE big lead pile at the Richmond refinery is fast increasing in size, and now contains, approximately, 3,300 tons of marketable lead, which, at the market price of five cents per pound, would bring $330,000. It is probable, however, that the company will not dispose of it for less than six cents, at which figures it would return $396,000. Without seeing this immense pile of metal it is impossible to form much of an idea of its magnitude. There are in the neighborhood of 46,200 bars in the pile, which average over 140 lb. each. If run into ordinary inch piping this lot would reach 893½ miles, and it could be distributed an inch thick over more than two and a half acres of surface.

AUTOMATIC MENTAL ACTION.

By Prof. J. M. LONG.

THE development of the life of man depends upon the dynamic arrangements in his constitution for action. Those who study man from both the physiological and the psychological point of view, should, therefore, take into the account all those springs of action with which the Creator has endowed him. That part of the physical nature of man directly concerned in action is the nervous system, the functions of which are the generation, transmission, and distribution of motion. That part of the nervous organism known as the cerebro-spinal system may be properly termed the physical mechanism of mind, because psychical phenomena are conditioned by its action. Psychical, or mental action, assumes three distinct forms, namely, reflex, latent, and conscious.

We have two kinds of reflex mental action—one natural and instinctive; the other artificial and acquired. Reflex mental action is that form of psychical phenomena which occur without the intervention of consciousness, and which, though unconscious, accomplish ends analogous to those which take place under the direction of thought and volition.

We have what is termed a reflex psychical action when impulse is sent along an afferent nerve from the surface of the body, and which, on reaching the sensory ganglia, is reflected or thrown back along an efferent nerve, in the form of muscular motion. In this case an ingoing movement, resulting in a sensation, is converted into an outgoing movement without an intervention of consciousness. Such movements are called automatic, because they are effected through the medium of the nervous mechanism mechanically, like the movements of automata. Illustrations of this class of psychic actions are furnished in the batting of the eyes when some object is suddenly thrust before them; in the unconscious throwing out of the hands to stay the body when about to fall; in the drawing up of the feet of a sleeping person when the soles are tickled.

To ascertain the seat of reflex psychical action has been one of the interesting and important questions of modern psychology. The study of psychical phenomena from the objective point of view has proved that the brain is not the sole seat of mind. The seat of consciousness is in the brain; but the other forms of mental action cannot be restricted to that organ, but are developed, with more or less intensity, in the other parts of the nervous system. Consciousness is the eye of the soul, and is, therefore, a faculty. But it does not thence follow that the mind is active only when this faculty is active. The mind has other sources and springs of action. Descartes, followed by many philosophers, identified consciousness with mind, as though one should confound seeing with perceiving. Unconscious mental action we regard as the basis and condition of conscious mental action. In pure reflex actions, the brain, or cerebrum, takes no part. They are effected through the medium of the spinal cord and the other motor centers, of which the cord is a prolongation into the base of the brain. Hence, animals of a low order, being more tenacious of life than those highly developed, when deprived of their brains will still perform reflex movements. Brainless pigeons will smooth down their feathers; brainless frogs will rub off sulphuric acid which has been dropped upon them, or adjust themselves on a board as it is inclined at different angles. Infants born without brains have been known to perform the usual operation of sucking. There is said to be a man in a French hospital who, in consequence of a wound received in the late war with Germany, passes out from his normal conscious life once in each month, and lives, for a day or two, a life of unconscious reflex action, like a decapitated frog or pigeon. He neither sees, hears, nor tastes, nor smells, having only one sense organ in a state of activity, namely, that of touch, which is exalted into a state of preternatural acuteness. Yet, without consciousness, he is said to go through his daily routine of movements with automatic regularity. All those accustomed actions he performs through the medium of the spinal cord and the other motor centers, independently of the brain.

Primary reflex mental action constitutes the innate and fundamental provision in the human organism for the maintenance of life. The conditions of life require that there shall be something from which to start at the time that the animal sets up an independent existence, in order that the organism shall be, to a certain extent, in harmony with environing relations. This primitive and innate provision for action is called instinctive, because it is original and unacquired, and exists in its full power previous to experience and instruction. Man, at birth, begins a life without knowledge and experience. In this condition his only guide is instinctive reflex action, until intelligence and volition become developed. Hence, instinctive reflex action forms the basis upon which all subsequent mental development and education take place.

The organism of man is arranged in harmony with a fixed and pre-established system of nature. To render the development of the organic and mental life possible, the rudimentary psychical nature must begin in unconsciousness, or reflex action, in harmony with the conditions imposed by external relations. As intelligence and will become developed, the mind rises into a consciousness of this pre-established harmony which from the beginning has rendered the development of life, both mental and organic, possible. Thus the mind grows and develops from simple reflex action—which presents psychical phenomena in their lowest typical form—into conscious volition, in which the intelligence adjusts itself to the complex relations of space and time. We thus recognize simple reflex action as the germ out of which will is developed. Hence, to understand the nature of will, we must study it in its genesis as related to reflex action. It is also by studying primary reflex-action that we become prepared to understand the nature of secondary reflex, or automatic action.

Secondary automatic mental action is one of the important contributions of modern psychology to mental science. Even after this doctrine had been stated and received as the only theory which could explain a certain class of mental phenomena, it was stoutly opposed by the metaphysical school of thinkers. Secondary automatic mental action belongs to that class of psychical activities which have, by the force of habit, assumed the form of aptitudes, and which go on without an effort of the will. Actions which, at first, require all one's attention, may, after many repetitions, become automatic, and go on, of their own accord, through the operation of the lower nerve centers, without a conscious effort of mind. The larger part of our daily mental actions which constitute the efficient machinery of life, is of this character, such as walking and reading aloud while the mind follows the thoughts of the author. If all the actions and mental processes which the necessities of our daily life impose upon us had to be brought under the review of consciousness, it would be burdened down with the weight of complex details. The use and value of consciousness as a mental element in running the machinery of mind do not lie in what it is in itself, but in what its separate and successive states may become. By continual repetition, these separate states may become organized into a consolidated whole, which, like the individual cells in the animal organism, finally develops into a complex form of automatic mental action. Hence, the mental machinery does not consist in separate conscious states, but in organized forms of action into which the mind has grown by the force of repetition.

The fact of mental automatism finds its explanation on the physical side of being in the relation which the cerebrum sustains to the lower sensory and motor centers. Impressions are made on the cerebrum by being propagated upward through the sensorium. These impressions, after being combined and co-ordinated, are reflected downward to the motor centers which execute the mandates of the will in the form of muscular movements. By constant repetition, these motor centers grow into the modes of action which have been consciously and artificially imposed upon them, so that the only conscious effort required to set them going is a mere initiative impulse of the will. In this way the mental and the physical organism may be made to take on themselves an artificial and secondary automatic action, as distinguished from that which is natural and primary.

We should not pass over this part of the subject without calling attention to the important office which this form of action performs in the economy of human life. We should regard the spinal cord, together with the motor and sensory ganglia, in which it terminates, as charged with spontaneous force, and as consequently the seat from which emanate "the lightning gleams of power" exerted for the well being of the organism. Man must have some provision in his constitution which shall serve as a guide and protection, before he can rise into the dignity of an intelligent and conscious being. Such are the dangers to which life is often exposed, that action must come before thought to save the organism, or some part of it, from destruction.

Automatic mental action has a most important bearing on education, whether this looks to physical, intellectual, or moral and religious training. It is that, in fact, which makes man an educable being. It is only the new school of psychologists who, as yet, fully recognize the great value of this form of action as one of the capacities of our physical and mental being. "It is," says Huxley, "because the body is a machine that education is possible. Education is the formation of habits, a superinducing of an artificial organization upon the natural organization of the body; so that acts, which at first required a conscious effort, eventually become unconscious and mechanical. If the act which primarily requires a distinct consciousness and volition of its details, always needed the same effort, education would be an impossibility." "The acquired functions of the spinal cord," says Dr. Maudsley, "and of the sensory ganglia, obviously imply the existence of memory, which is indispensable to their formation and exercise. How else could these centers be educated? The impressions made upon them, and the answering movements, both leave their traces behind them, which are capable of being revived on the occasion of similar impressions. A ganglionic center, whether of mind, sensation, or movement, which was without memory, would be an idiotic center, incapable of being taught its functions."

The educators of youth should never lose sight of the fact that their work is well done only when both mind and body have been trained to act with automatic readiness and precision. This high degree of mental and physical power and specialization can be attained only by incessant repetition. Practice, and practice alone, makes perfect.

All beginnings are difficult; but, by virtue of this capacity for automatic mental action, they become easy and pleasant, so as to require little or no effort of the will to spur the mind on to its accustomed work. After this form of mental action has once been acquired, the mind is no longer perplexed with the routine of petty details, but is left free to attend to the few unaccustomed matters which turn up during its regular work, and which require a distinct consciousness.

The educator of youth, in availing himself of this spring of action, must take into account the question of vital dynamics. Unless he does this, he is liable to err in two particulars: first, as to the extent to which this form of mental action should be carried; second, as to the class of mental operations to which it should be confined. Automatism requiring long and laborious repetition must make a heavy draught upon the plastic energies of the brain. The consumption of all the nervous energy in organizing automatic forms of action would result in a deadening of consciousness, and tend to reduce the mind to the level of a machine. Prof. Huxley says that he would not object to being thus reduced, provided that when wound up in the morning like a clock, he would run on with automatic precision, and never go wrong. But such a result, if possible, would not be desirable, for the reason that it would put an end to all further mental progress in making new acquisitions. Mental operations by repetition tend to wear for themselves a channel. The nervous mechanism embodies in its structure the impressions made upon it as a part of its organic growth. But this mechanism of nerves is truly a machine, governed by mechanical laws, and is hence capable of performing only a limited amount of work. If a certain amount of the brain force be consumed in impressing upon the organism a particular form of action, just so much less will be left as a stimulus for exciting the mind to other acquisitions. Hence, if automatism has been carried to excess, the effect upon the young and growing organism must be injurious. The rigid and automatic condition of the nervous mechanism produced by habit brings on a corresponding rigidity and deadness of consciousness itself, thus rendering the mind incapable of further progress. Automatic action gives efficiency and ease of execution; but, if carried too far, renders it difficult and even impossible to make new acquisitions.

It is also evident that automatic action should be confined to those mental and physical movements which will be of daily use, which look to the practical side of life, and which, from their nature, must be largely automatic to fulfill their ends. Learning to play on the piano, or other musical instrument, must attain to automatic quickness, to give that ease and readiness of execution which the nature of the process' demands. The fundamental operations of arithmetic should be so thoroughly learned as to be largely automatic. When these fundamental processes of numbers have become organized, as it were, in the mental organism, the mind is then left free to attend to the logical processes involved in the mathematical operations. But, for the reason that automatism is an expensive acquisition, it should be limited to such mental operations as necessarily demand it. Those operations which can be well performed by deliberate thought should be left to the conscious control of the will.

1. The education of the mental organism into automatic action should begin early, while the nervous system is plastic and impressible.

2. One of the practical problems of education is to duly antagonize consciousness and automatism.

3. The energies of childhood should not be utilized in the automatic demands of business, for this would bring on an arrested development of mind and body.

4. The mental life of the school demands that provision should be made for the exercise of both these forms of mental action, the automatic and the conscious.—*Kansas City Review.*

VOLCANIC ERUPTIONS AND EARTHQUAKES.

According to Herr Fuchs there were last year only three eruptions, none of which were of extraordinary violence. The most notable was that coincident with the appearance of a new volcano in Lake Ilopango, in San Salvador, following on a series of violent earthquakes, in December last. This raises to six the number of active volcanoes in that state; and there are five extinct. The eruption of Etna, beginning on May 26, was specially marked by an uncommonly long lava stream—16 kilometers. The preceding earthquakes were not very great. Yet the mountain mass opened in a chasm of rupture 10 kilometers long, cutting the principal crater. The north-eastern and higher end of the chasm presented the more numerous and larger craters, whence came the great branching lava stream, the central part giving only steam and fine ashes. This eruption ended in eleven days. The third eruption was that of the volcano Merapi, in Java, on March 28. It gave lava and ashes abundantly. Several other Javan volcanoes, as also Vesuvius and a submarine volcano south west of Iceland, were in a somewhat active state. Of the 99 earthquakes which came to Herr Fuchs's knowledge only a few were of remarkable strength. On the night of March 22 a violent earthquake was felt in northern Persia for several hours, and destroyed a number of villages; from that date to April 2 (when the last vibrations occurred) some 900 persons perished. The earthquake of April 25, in the Romagna (Italy), was also of unusual strength; the valley of the Senio was most affected, and in Palazzuolo numerous buildings were thrown down. Another very violent earthquake occurred on May 17 in Mexico; the ground movement was observed in all the region from Vera Cruz to the town of Mexico, and in Cordoba and Orizaba great injury was done. On June 29 violent earthquakes began in a part of China and extended over thirty districts; in this case the phenomenon of huge water jets spouting up through the opened ground was observed. The shocks were repeated till the middle of August, and many hundred lives were lost. This feature of fountains marked several other earthquakes in 1879—*e g.,* one in Bessarabia in May, which commenced with a detonation like that of a cannon; and one on the lower Danube, from October 10 to 18, when a large fountain and several small jets appeared on the island of Babacay. To the violent earthquakes belong, also, those which preceded the formation of the new volcano in Lake Ilopango. Of German regions, Carinthia and Carniola were the richest in earthquakes last year. The first earthquake occurred on January 11, reaching through the Lavan valley and much further. On February 2 it was repeated, being strongest in Carniola, and extending over parts of Carinthia, Styria, and the coast-land. A third violent earthquake occurred on May 8 on the southern slope of the Ston, between Carinthia and Carniola; it was like a blast in a mine. On October 1 Klagenfurt was the chief scene of an extensive earthquake. Several others of less importance were experienced. Next after this region comes the north-west Rhine region, which since 1873 has been often affected. The south-western Schwarzwald, too, experienced several shocks last year. This district has of late formed part of a large earthquake region, comprising Western Switzerland, Eastern France, and South Western Germany, the principal line of action extending from the Lake of Geneva over Basle. In the German Empire earthquakes occurred on thirteen days and at nine different points, as follows: Buir (Jan. 3 and April 9); Aachen (Jan. 10 and May 26); Schwarzwald (Jan. 26 and Dec. 5 and 22), Lachthal (Feb. 9), the Bavarian-Tyrol boundary (Feb. 17), Gebweiler (Feb. 20), Saxony (March 12), Harburg (Nov. 17), Muhlhausen (Dec. 4). The days of 1879 on which there were the most earthquakes were Feb. 14 (Brusio in Graubunden, Laibach, Arco in Tyrol), and July 2 (Athens, China, Burg, near Greifenberg).

DEATH OF THE OLDEST ENGINE DRIVER.

In April last there died, at Salford, England, James Lamb Turner, who at the time of his decease was probably the oldest locomotive engine driver in the world. On the occasion of the opening of the Liverpool and Manchester Railway, on the 15th September, 1830, he was one of the firemen in the grand procession of engines which came from Liverpool to Manchester. Turner was fireman on the "Dart," his engineman being Robert Hope, whom George Stephenson had brought with him from the North of England. In another respect James Turner might have laid claim to seniority of all the army of railway martyrs—he was probably the oldest. Three weeks after the opening of the railway he was engaged as stoker near Rainhill, pushing a wagon upon the line before his engine. There were upon the engine the late Mr. Murray Gladstone, his brother Montgomery, and the son of another director of the company, when suddenly the wagon left the rails and threw the engine on its side.

The engineman had jumped clear, and the three young gentlemen escaped, but the poor stoker was imprisoned under the engine in a flood of scalding water, and there he lay with his legs fast for a considerable time. He suffered from the effects of that accident to the end of his life. Turner continued to act as engine driver during the ownership of the line by the Liverpool and Manchester Company, the Grand Junction Company, and the London and North-Western Company, till 1859, when he retired. He was one of the earliest men in Lancashire who took part in promoting the oldest railway benefit society in the kingdom—viz., the Locomotive Steam Engine and Firemen's Friendly Society, which was founded at Birmingham in the year 1830.

NEW SYSTEMS OF IRON BRIDGES.

During the last twenty years rapid improvements have been made in the construction of iron bridges, and like all important developments, these improvements have taken place progressively. Numerous and most varied systems have succeeded to one another, and the opinions that have been formed with respect to the merits of the different forms of construction have changed from one year to another.

The improvements that have taken place in the manufacture of iron and steel have furnished constructors with increased facilities for carrying out their ideas.

Theory, as well as practice, has helped to develop new resources, which in their turn have led eminent engineers to set themselves the task of furthering the advancement of engineering science.

In recognizing the fact that the authority of men of rank has often exerted an important influence upon the development of an art, it must be borne in mind that too frequently it is not the superior knowledge, but the exalted position, of the author of a scheme which favors the realization of a new idea. This will explain the fact of the inferiority of many modern constructions, and in this case their chief scientific value lies in the addition they have made to the experience already acquired.

Among the numerous efforts that have been made to introduce new principles and more advantageous forms, our attention is called to two points: the first of those is the tendency to construct wider spans, which shall possess as great a strength as possible; the second, to invent new systems of construction which shall permit of all their members being readily calculated.

For wide-span bridges we must admire the imposing works of the American engineers, who have achieved brilliant successes by their magnificent suspension bridges of a length at present unknown in Europe.

If these constructions have not a yet greater development in Europe, the reasons for such being the case can be readily understood by all who are acquainted with the differences which exist in erecting work in America and at home.

Moreover, it has been discovered that lattice girders, which are generally used in such constructions, are not economical in the case of large spans; besides which, their weight alone, when they are beyond a certain length, becomes an obstacle to their use.

The Kuilenborg bridge in Holland, which has one of the largest spans known, reaching a height of 492 ft. 2 in. by means of a parabolic structure, is an example of the successful application of lattice girders.

We must confess, however, that at first sight we are inclined to adopt arched bridges in preference to any other; but after mature consideration, it will be seen that these systems are generally more complicated than those having lattice girders, and that the calculations are, if not impossible, at least extremely difficult to make, when no articulations are used for the supports or at the top of the arches.

Experience has taught us that arched bridges having three articulations have not, in all cases, been sufficiently strong; and it has even been observed that shocks have been distinctly felt, especially in the middle of the arch.

This has been the reason that the plan of arranging articulations in the middle of long-curved girders has been abandoned, and that the bridges of which they form a part have been provided only with hinged supports. A striking application of this method is found in the new railway bridge erected, in 1878, over the Rhine at Coblentz, and which consists of curved girders of 351 ft. 1 in. span.

The superstructure is light and economical. It was, however, found necessary to introduce sufficient metal into the construction to prevent the effects which would otherwise result from the variations of temperature that take place at the highest part of the structure.

The possibility of making use of the horizontal resistance of abutments by excluding the inconveniences resulting from the uncertainty of the functions of forces, suggested, a few years ago, several schemes involving novel principles of construction.

The first to take a bold step in this direction was M. Köpcke, of Dresden, Councillor to the Saxon Minister of Finance, an eminent engineer who, in 1865, published in the *Zeitschrift des Architecten und Ingenieur-Vereines zu Hannover,* a treatise dealing with this question in a very exhaustive manner. In this work he explained the improvements which had been made in the art of constructing iron bridges up to that time. After pointing out the superior qualities of various systems from a statical point of view, and among others the great value of articulated girders, the author proceeded to treat of the subject of bridges having large spans.

We have already observed that the great weight of a lattice girder of great length is an obstacle to its use. M. Köpcke proposed a new system by which the spans could be increased without adding to the cost of construction. His scheme consists in counterbalancing a portion of the load of a bridge by a weight placed in an abutment, by which means an external force is applied for the purpose of counterbalancing internal strains in the girder.

In Fig. 1 we give a sketch of one of these arrangements, from which the principle will be readily understood.

The girder, which has a parabolic shape, rests at one end upon plates provided with hinges and rollers, the other end being supported on fixed plates. The movable end rests on an articulated prop which is supported on the bottom part of the abutment. A weight capable of rising and falling and of acting on the articulation of the prop, exerts a certain pressure upon the girder. Now, let us suppose that the effect of the weight be such that the horizontal pressure it exerts on the structure is equal to the constant strains which, under ordinary conditions, are produced in the lower flanges of the girder by the permanent weight of the structure. The straight arches will, in this case, have no action; and the upper flanges, acting like ordinary curved girders, will support the permanent weight of the bridge.

As soon as an accidental load begins to act on the bridge, the lower flanges begin to act, and under the influence of this charge the upper part of the structure acts like an ordinary parabolic girder.

Viewed in this light, the new method of construction can be considered as a combined system of curved and parabolic girders definite as regards statics.

At first sight, this system will appear exceedingly strange, as the author himself confesses; but a nearer examination will carry the conviction that there is nothing absurd in it.

Independently of the elastic qualities of the metal used, it further enables light structures of very large spans to be erected with great economy; for the lower flanges are much reduced in section compared with those of an ordinary parabolic girder.

It must not be forgotten, however, that the abutments have to resist a thrust in the horizontal direction the force of which will depend upon the balance-weight, and consequently they must be built like those of an arched bridge. From this point of view it might be objected that the cost of the necessary foundations and masonry would more than counterbalance any economical advantages to be gained by the adoption of the new system; and, in certain cases, this objection must certainly be admitted.

Only comparative calculations would have to be made, and these would never militate against the system, unless the foundations of the abutments should prove excessively costly or if it should be required to erect several large spans of equal length.

It must be added that, in order to apply this system to several spans, the girders of each succeeding arch will be placed end to end without being connected in any other way.

The brackets on the piers are provided with hinges and rollers, one of the abutments being provided with an equilibrium apparatus, while the other is designed to offer resistance to the equilibrium weight by means of a kind of iron prop, the object of the latter being to transmit the horizontal thrust to as low a part as possible of the abutment.

The alternate expansion and contraction of the girders, due to variations of temperature, is provided for without difficulty, by having one end fixed and the other counterbalanced, so as not to oppose any resistance to such movements, while the resistance offered to the rolling of the resting plates is comparatively slight.

If the preceding considerations be summed up, it will be seen that the fundamental principle of the new system consists in relieving the load of girders, whatever be their forms, by means of external forces.

It was from the same point of view that Herr Föppl, an engineer of Leipsic, treated the subject in the *Deutsche Bauzeitung*, for 1875, and also in a work called "New Systems of Iron Bridges," which was published in 1878. We find in these papers several suggestions bearing on the manner of introducing moments of external forces in the girders. Moreover, their application is most varied, and those who interest themselves in this question will soon discover different methods of adapting the new principle to any special case.

Herr Foppl further describes in the above-mentioned work, a system of bridge which he calls "girders with inclined supports," of which we give a sketch in Fig. 2, and which, in so far as its form is concerned, should be considered as an ordinary parabolic girder, although the effects of the load would have to be otherwise explained. Thus, the curved arches and the lattice work will have the same strain as those of a parabolic girder placed horizontally, but the tensions in the lower arches will depend on the inclination given to the supports. The latter consists of hinged plates, one of which is fixed, the other being movable upon rollers. The calculations of the system are thus complete and exact, without the necessity of having recourse to the rules of elasticity. It is only necessary to determine, for the different ways of loading, the components of the resistance of the movable supports, in order to illustrate the working of this system; 0 being one of these components, namely, the one acting in a direction parallel to the inclined plane of the movable support, it is evident that the other will operate perpendicularly to the inclined surface of the abutment.

The expansion of the beams can take place freely, owing to the rollers applied to the movable support. In order to compensate for the effect of the movement of the free end of the structure, it will be necessary to construct a portion of the flooring in such a way that it may regulate the variable height of the point of support. For this purpose the inventor proposes to arrange a kind of small movable bridge which shall connect the girder with the flooring.

Herr Foppl states that, by means of this system, fifteen per cent. of the weight of the structure can be saved, compared with the parabolic girder placed horizontally, and this assertion appears to be quite true.

With regard to the abutments, they must be of sufficient strength to resist the horizontal strains produced by the load of the girder, and the considerations made above are therefore equally applicable in this case.

The systems above described would only be interesting to the theorist if we were not able to show their practical application. Such an application has been made in a bridge recently built over the Elbe, near Riesa, in Saxony. This bridge was constructed to replace the former bridge which crossed the river at a point some thirty-three yards below, and was destroyed in 1876 by an extraordinary flood, when a pillar undermined by the water gave way, and the iron superstructure, which was hardly completed, fell into the water shortly after the passage of a train. Although resulting in no loss of life, this accident had nevertheless serious consequences. The damage was not confined to the loss of the bridge itself, but consisted chiefly in the obstruction which was caused by its *débris* to the important navigation of the Elbe.

The new bridge, which was completed in the beginning of 1879, consists of four spans, three of which are provided with a girder 328 ft. in length, whereas the last beam has only 157 ft. 6 in.

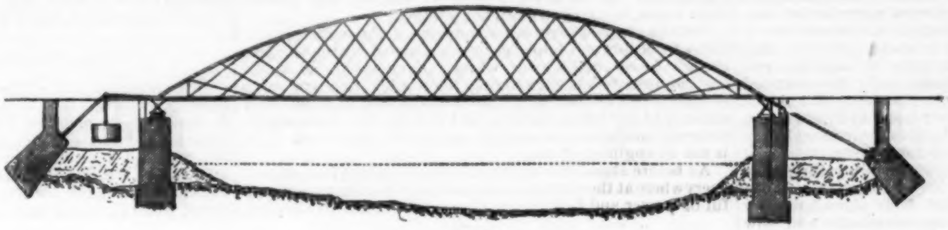


Fig. 2.

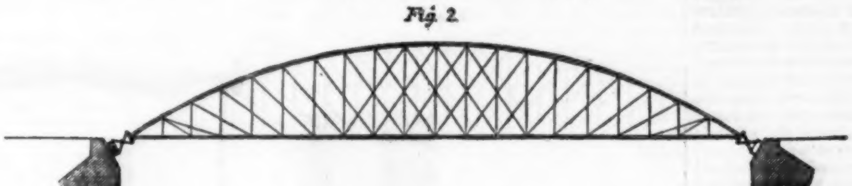


Fig. 3.

COMBINED CURVED AND PARABOLIC GIRDER BRIDGES OF LONG SPAN.

Fig. 3 is a sketch of this bridge, from which it will be seen that the outer form of the girders is parabolic.

By means of separate constructions, which are independent of one another, the bridge gives passage to a carriage road as well as to the railway line from Leipsic to Berlin. The Kopcke system was employed in the superstructure of the road bridge.

Several modifications of the details were made in the course of construction.

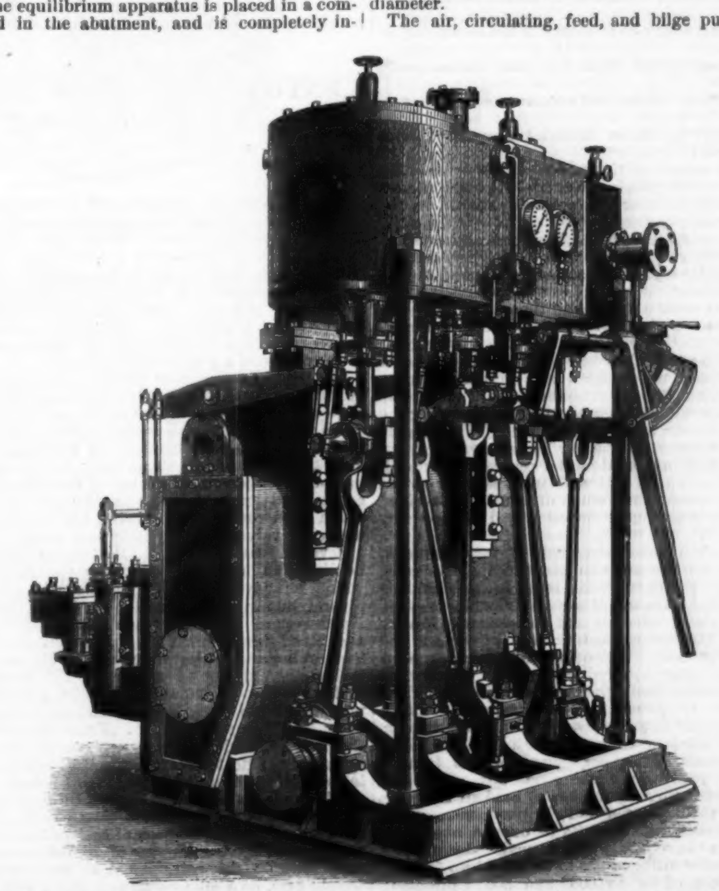
In this case the equilibrium apparatus is placed in a compartment formed in the abutment, and is completely inclosed. The balance weight acts upon double-armed levers, one arm of which is half the length of the other. Two parallel levers are arranged, corresponding to the two trusses of the girders, and are connected by rods which carry the balancing weight. A junction by means of cross-bars allows these levers to offer resistance to the torsional forces which are produced in a lateral direction. The levers thus connected revolve around fixed points, which have the form of hinged brackets, and are fixed to the lower part of the abutment. The balance weight consists of bricks of slag having a specific gravity of 3·2, and weighs 295½ tons. This weight, by acting on the longer arms of the levers, exercises on the structure, by means of two other arms and two connecting rods corresponding to the trusses of the superstructure, a horizontal pressure of about 590 tons, which is transmitted from one girder to another, and resisted at the second abutment by means of two iron props. The connections of these different parts are made so as to permit of articulation.—*Universal Engineer.*

SMALL COMPOUND ENGINES.

WE give an engraving of a pair of compound screw engines of a type which has now become a favorite one for small powers in the Clyde district. The particular engines illustrated are rated at 25 horse power nominal, and have been constructed by Messrs. Ross & Duncan, of Glasgow, for the steamship Allan Macdonnell, a vessel lately built for the Newry Salt Works Company. The high-pressure cylinder is 13 inches in diameter, and the low-pressure cylinder 23½ inches in diameter, while the stroke of both pistons is 18 inches. The surface condenser forms the base of the back columns, being cast in a piece with them. It has a large cooling surface of solid drawn brass tubes ¾ inch in diameter.

The air, circulating, feed, and bilge pumps are worked by rocking levers from the crosshead of the low-pressure engine. The reversing gear consists of link-motion, and, being of a size easily handled, is worked direct by a hand lever. The general design of the engine is compact and substantial, and such as to admit ready access to all the parts. All the rods are polished and have brass brushed joints, easily adjustable.

Steam is supplied by a high-pressure cylindrical boiler with two furnaces and return tubes. The total length required for engine and boiler space is about 23 feet. This



SMALL COMPOUND ENGINE OF THE S. S. MACDONNELL.

class of engine, says *Engineering*, is altogether superseding the high-pressure non-condensing and the low-pressure condensing engines formerly so general in coasting vessels, and, of course, effects a large saving in coal to the owners.

THE STEAM ENGINE AS A MOTIVE POWER FOR MILLS.

By J. F. TALLANT, M.E.

VERY few persons, even those who regard themselves as skilled engineers, have any conception of the enormous waste of caloric or heat caused by using the steam engine in ordinary practice. This is also the case with some other very important technical interests.

As an instance, usually, not less than nineteen-twentieths of the fuel is actually wasted and thrown away in the common slide-valve steam engine, of which the locomotive is the type, barely five per cent., and in many cases not that amount of steam power in the coal being utilized for real paying duty. Scientists have also repeatedly demonstrated that in one pound of good English or Pittsburg bituminous coal there is a real illuminating power equal to 12,410 sperm candles burned one minute. But in actual practice, barely 12 to 15 candle power is realized for consumption and beneficial service in the ordinary gas factories for public supply.

These well-known and undisputed facts show how very imperfect are our present boasted improvements, and how much yet remains to be accomplished to come anywhere within seeing or hailing distance of perfection. Yet such is the conservatism, prejudice, and incredulity of experts, both engineers and engine builders, that little encouragement is offered to those daring inventors who attempt to make innovations on the old-established practices. Like the old-fogy farmer with his grist, we still carry the bag across the horse, with a stone in one end to balance the grain in the other. Only we do it in a very different way.

The researches of Fabre, Silvermann, and other investigators of caloric, as a source of power, have all proved that a pound of coal of good average quality will liberate, during complete and perfect combustion, 14,000 to 15,000 units of heat, each equal to 772 foot pounds, or pound weights raised one foot in one minute.

The mechanical equivalent of the heat produced by burning a pound of coal is, therefore, say $14,500 \times 772 =$ or upward of 11,000,000 foot pounds. A horse power is assumed to be equal to 33,000 pounds raised a foot a minute, or 1,980,000 foot pounds an hour. Thus the perfect combustion of each pound of coal creates heat enough to develop $11,000,000 \div 1,980,000$, equal to, say, five horse power. In a perfect steam engine the coal burned would be about at the rate of one-fifth of a pound per hour per horse power.

Ordinarily, the best results attained in continuous working may be taken at three to five pounds of coal per indicated horse power, with common high-pressure engines, and two to three pounds with low-pressure condensing engines. Less than this is often reported, but is very rarely attained. Burning four pounds coal an hour per indicated horse power means a loss of nineteen-twentieths, and of two pounds, a loss of nine-tenths. This last is so seldom reached, even by the most perfect machinery, that the need of improvement ought to be apparent to every user of steam power for any purpose.

The conditions necessary to economy in the steam engine are:

1st. Complete combustion of fuel in the furnace, with little or no smoke.

2d. Total transfer of all the heat created to the water in the boiler.

3d. The passage of the steam through the engine without condensation or loss of heat.

4th. Absence of useless friction and steam pressure in the working of the engine, which must run with the utmost ease and absence of noise or jar, or loud exhaust, in the case of a high-pressure engine.

How these requisites may be at least partially attained should be the study and prime object of every skilled engineer. He may waste many thousands of dollars of his employer's capital without being able to trace where it went. He ought to be able to save them at all times.

As to the combustion of fuel, the most careful firing allows a considerable portion of coal to fall through the grate bars unburned. The writer once saw a premium engine at a fair run with hazel nut coal, thrown into the furnace every minute from a small shovel holding a half pint. The combustion was so complete, by spreading the coal over the live fire, that no smoke at all could be seen. This engine used less than two pounds of coal per horse power an hour. But, of course, such firing could not be generally practiced. Usually the loss in waste coal and unconsumed carbon reaches fully ten per cent., and much of it may be avoided by having properly constructed furnaces and a good fireman.

Loss of heat, when once generated, is very common. Much of it is lost in radiation from the furnace, flue caps, smoke stacks, etc. The greatest loss is caused by admitting into the draught a large amount of useless air and inert gases, and the escape of these, intensely and unnecessarily heated, up the chimney. The atmosphere consists of oxygen and nitrogen gases combined. But only the former supports combustion. The latter totally destroys it. The useless nitrogen merely extracts heat from the fuel and cools off the furnace. About 12 pounds of air contains oxygen enough to burn up one pound of coal, but in ordinary practice the quantity required to go through the furnace is from 18 to 24 pounds of air per pound of coal burned. The surplus air really does no good, but causes an actual loss by abstracting useful heat. Said air is always composed of 21 parts oxygen and 79 parts nitrogen in 100 parts, and in getting the quantity of oxygen absolutely necessary to obtain the requisite heat to make steam, three and a third times more nitrogen has to be heated up from an average temperature of 60° to 600° and 800° Fahrenheit, even if it is a positive extinguisher of flame and heat. The loss from this cause is fully 30 to 50 per cent., for while each pound of coal ought to evaporate 16 to 18 pounds of water, in ordinary practice it seldom evaporates more than 6 or 7 pounds, and frequently less than that. In securing the maximum economy both of fuel and power, enough air to produce the required effect, and no more, should be furnished at the furnace draughts, and if previously heated, as in the case of the hot-air blast, which has produced such a revolution in iron forges, the saving of fuel would be still greater.

The great problem to be solved is to avoid this loss. By having energetic combustion and a high temperature of furnace, the quantity of air needed may be much reduced. By proper arrangements for feeding coal and admitting air to the furnace, the proportions of each may be suitably adjusted to each other. With a skillful adjustment of heating surface and the use of a fan blower or steam jet, the waste heat may be kept down to about 400° or less, and an evaporating power of 9 to 11 pounds of water to one of coal may be obtained. This result is not unknown in actual practice.

Among the minor losses of heat in the steam may be enumerated useless radiation from the boiler, steam pipes, and engine cylinder. Some of these may be avoided by placing the engine close to the boiler and carefully lagging and packing all exposed surfaces. A great saving is made by using a properly-jacketed cylinder and a well-lagged boiler, that the steam may be projected into the engine hot, elastic, and full of energy, going in and out like powder from a gun, not cold, sobby, and lifeless.

But the greatest loss, in the opinion of the writer, is suffered from bad and imperfectly constructed steam engines, though losses occur everywhere. Even at this advanced day, so imperfect is engineering knowledge that engineers dispute, even as doctors are proverbially said to differ, over points and facts that ought to be as plain and indisputable to every intelligent man as the nose on his face, even if he is not an engineer at all.

As before stated, the slide-valve steam engine is most used everywhere at the present time, and is by far the most wasteful of power and fuel of any device that could be adopted. Its chief merits are cheapness of construction and ease of management. When these are mentioned the sum total of its advantages is named. While any boy or man who knows how to keep water in a boiler and oil or grease on moving joints, may be said to be capable of running it, yet the skilled engineer is always worth good pay, and, when he can be procured, ought always to be sought after and employed in preference to any common monkey-wrench slinger. He will always make his wages many times over in the course of a year for his employer.

The slide-valve engine consists principally of a steam cylinder with a square valve seat containing three apertures or ports on the side, or on top, on which slides a flat valve with a D-shaped cavity on the under side, which is moved by an eccentric keyed to the main shaft. Whatever the pressure of steam may be in the boiler, that pressure bears down on the top of the valve, less the loss by cooling and condensation in passing from the boiler to the steam chest containing the valve, and also less any pressure under the valve, in the cylinder and steam passages.

Several years ago W. G. Beattie, an English engineer, published an interesting article in the *London Artisan*, in which he gave the following mean or average report of several hundred tests made by him on the London and Northwestern Railway, which demonstrated the immense weight of this pressure: "A locomotive engine, with 18-inch cylinders, carries slide valves 10½ inches long by 17 inches wide, giving an average of 176 square inches area under pressure throughout the stroke, amounting to a total pressure on top of each valve, with steam at 125 pounds, of about 22,000 pounds. . . . From this must be deducted the pressure under the valve, given by the steam in the cylinder. Indicator diagrams prove this to be 435 pounds in the first third of the stroke, 1,901 pounds in the second third, and 2,133 pounds in the last third, or a mean weight or pressure of 1,490 pounds throughout. Deducting this from the weight on the back of each of the two valves, there remains an effective pressure of 20,510 pounds on each, or 20½ tons on the pair," equal to the weight of two box freight cars, or a solid column of iron a foot square, 84 feet high, concentrated in the confined space of the chests on top of a pair of locomotive cylinders, which must be started, stopped, and started again twice at every revolution of the drivers before a train of cars can be moved at all. Nor is this enormous weight on wheels. It is dragged back and forth by main strength continually, iron to iron, on solid planed flat surfaces.

As a proof of the enormous power required to move these valves, the writer once saw the valve stem of a locomotive detached, and, by means of a chain, a steel bar 12 feet long was attached to it, which could be moved with ease by one man before the steam was applied; afterwards eight men were unable to stir it, with a leverage of ten feet to one.

In what may be regarded as a first-class modern steam engine of the slide-valve type, the heat in 100 parts of the coal used may be thus disposed of:

Lost through careless firing and unconsumed coal	10	parts.
Carried off in useless air and gases	30	"
Lost in the exhaust steam and useless pressure	50	"
Utilized as power for actual duty	10	"
	100	"

This may be regarded as a showing that few steam engines can make, yet these results have been exceeded in the knowledge of the writer by some of the more improved devices. In selecting an engine for profitable use, these requisites should be borne in mind, and the advice of disinterested experts, other than the builders of steam engines, should be procured, when possible.—*The Milling World.*

KENYON'S INDICATOR.

WE annex an engraving of a new type of steam engine indicator which is now being made by Messrs. Isaac Storey & Sons, of Manchester. In this indicator the ordinary cylinder and spring loaded piston are done away with, and are replaced by a Bourdon tube of special construction. One end of the Bourdon tube is attached to the stem of the indicator by a joint (see Fig. 2), which can readily be taken apart, while the other end is connected by a link to a system

FIG. 1

KENYON'S PISTONLESS INDICATOR.—CONSTRUCTED BY MESSRS. ISAAC STOREY & SONS, ENGINEERS, MANCHESTER.

of parallel motion similar to that used in the Richards indicator. The link which connects the end of the Bourdon tube to the parallel motion has spherical joints at its ends, and it is placed so as to be directly over the axis of the stem in which the arm carrying the parallel motion turns, this arrangement being, of course, adopted to prevent it from being materially influenced by the arm being swung round to bring the pencil against the paper.

The Bourdon tubes are changed when different pressures are to be dealt with, just as the springs are changed in an

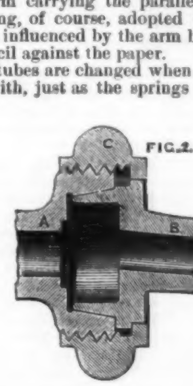


FIG. 2.

ordinary indicator and with no greater trouble. The motion is given to the paper drum in a similar manner to the Richards indicator, but when desired the instrument is fitted with a simple detachment motion which enables the paper drum to be instantly released from the revolving cord drum, the paper drum being thus left at rest, so that the paper can be readily removed and replaced. It is claimed, among other advantages for this indicator, that it is practically frictionless, that its action is not affected by dirty steam, and that there is no annoyance from the escape of steam.—*Engineering.*

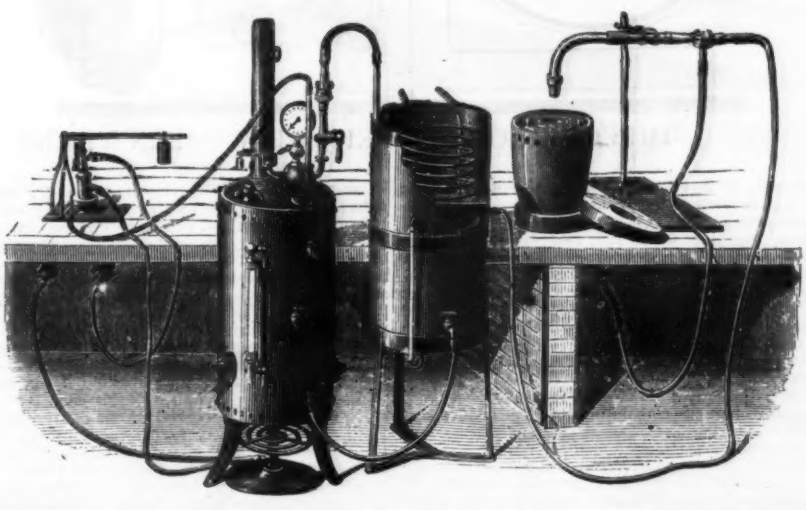
ANNEALING IN BOILING WATER.

PROF. W. MATTIEU WILLIAMS says: "I will narrate some curious experiments that I commenced when in Sheffield, but have not satisfactorily completed. They were made at the suggestion of Mr. William Bragge, then a managing director of Sir John Brown's works. He had learned that the steel wire springs of pianofortes are annealed by what appears a very ominous process, viz., by making the wire red-hot and then plunging it into boiling water. Ordinary experience would suggest that this must harden the steel in some degree, but I tried upon many samples of steel—mild Bessemer steel, shear steel of different qualities, and the hardest old-fashioned Sheffield 'pot steel'—and found

that in every case, when the operation was properly performed, the steel was remarkably annealed. I compared samples cut from the same bar—one heated and slowly cooled by burying in ashes under a furnace grate, the other by immersion in boiling water—and found that when subjected to bending tests, those which had been cooled in boiling water would bear a more severe degree of flexure without cracking than the pieces which had been more slowly cooled in the ashes. They were not so soft, as tested by the touch of the file, but unquestionably tougher and more reliable when subjected while cold to the violent bending blows of a hammer. It was more effectual than any device of 'oil toughening' or slow cooling I have had opportunities of testing. Certain precautions are necessary. In the first place, the water should be quite at the boiling point, and the steel at a bright red heat; and, secondly, the steel should be fairly surrounded by the water. These conditions being fulfilled, the steel remains red-hot under water for some time. It is evidently surrounded by a film of vapor, and is not in actual contact with the water, which assumes the so-called 'spheroidal state,' continuing in this condition until the metal has cooled considerably. I suspect that the toughening is due to the uniformity of cooling thus effected. I commend this method of annealing or toughening to the attention of manufacturers engaged in the production of all kinds of steel that is to be used for purposes where tenacity rather than hardness is demanded."

STEAM BLOWING APPARATUS FOR LABORATORIES.

THE principle of the apparatus illustrated in the annexed engraving consists essentially in the drawing in of a current of air by means of a jet of steam which, on condensing in its passage through a cooled worm, reassumes a liquid state and separates from the air that it has introduced. This principle is not new, since an application was made of it along toward 1845, by Mr. Bourdon; but the arrangement devised by Mr. Wiesnegg gives a more practical bearing to it. As shown in the figure, the steam generator is heated by gas, and consists of a small, rapidly circulating boiler. The steam is kept at a constant pressure, and the supply of gas is regulated, according to the escape of steam, by means of an Arsonval pressure-regulator. The condenser is an ordinary worm, provided with a reservoir wherein accumulates the condensed water, which is again used to replenish the boiler, thus consequently providing against the danger of incrustation. One of Arsonval's temperature regulators is fitted to the condenser, allowing of an automatic regulation of the outflow of the cold water which is to condense the steam. This arrangement is highly advantageous in cases where the quantity of water at one's disposal is limited. On issuing from the condenser, the air, carrying along with it the gas, enters a Schloesing's mixing tube. The furnace, properly so called, is a plumbago crucible having several partitions. By means of this simple and ingenious arrangement, it is possible to melt in a laboratory pieces of iron and steel weighing from ten to twelve pounds. It is hardly necessary to point out how useful such an apparatus must prove in a chemical or physical laboratory, where it can be employed for compressing air, creating a vacuum, distilling liquids, etc., and also as a motor power.



STEAM BLOWING APPARATUS FOR LABORATORIES.

HEVEENOID.

By HENRY A. MOTT, Jr., Ph.D.

HEVEENOID is the name of a new product which is destined to supplant the soft and hard vulcanized India-rubber which has for so long a time supplied the market. The base of heveenoid is India-rubber, whence the name, from *heveen*, the name given by the natives of South America to the milky juice of the India-rubber tree; and *oid*, a Greek termination signifying *like*. The combination of this base with camphor vulcanized by sulphur constitutes *Heveenoid*. The discovery of Goodyear and Day, that sulphur will vulcanize India-rubber, first made this substance of value in the industrial arts. While this discovery must always be looked upon as one of great value, the discovery of the new product, heveenoid, by Henry Gerner, opens a new era in the rubber industry, and will, unquestionably, to a very great extent, in time, take the place of the vulcanized rubber of to-day. The process of manufacture of heveenoid may be very briefly described as follows:

Pure India-rubber, whether it be Para, Nicaragua, Madagascar, or African, is first boiled in water, after which it is passed between rollers, one of which is ridged; a stream of cold water is allowed to flow over it, when it is torn in all directions, the water washing out the sand and other foreign impurities. It is next hung up to dry in a room, the temperature of which is 120° to 150° F., and left there for five to six days, when it is in a condition to be baked on rollers, the object of which is to make the rubber more homogeneous, after which it is rolled up and laid away for use. The next stage in the manufacture is the incorporation of the other constituents with the rubber thus prepared. The principal constituents to be incorporated are camphor and sulphur. These two substances are usually united together first, before combining them with the rubber, and there are several processes to bring about their union. The camphor may be melted and then poured on the sulphur, or both may be melted together, the two substances being thoroughly stirred and then allowed to cool, when it may be ground and reduced to powder, which latter process is facilitated by moistening the mixture with either alcohol, naphtha, gasoline, or benzine. This powder is then in a condition to mix with the rubber. The camphor could be dissolved in some menstruum, such as alcohol, naphtha, etc., and then poured on sulphur and such other substances as are to be incorporated with the mixture, the whole being thoroughly stirred, when the solution may be evaporated and the product ground to a powder, as above. Another method which has proved very practicable is to mix the camphor and sulphur thoroughly under rollers, after which it may be ground in an ordinary grinding mill.

The powder prepared by one of the above processes is next directly incorporated with the prepared rubber, which was laid away for use. The rubber is passed between rollers, one of which is run somewhat faster than the other, and as one roller is hotter than the other, the rubber naturally adheres to that roller. During its revolution the constituents to be added, in a powdered condition, are fed through a hopper placed over the rollers; the rubber is from time to time introduced in mass between them; by doing this, the constituents are thoroughly intermixed throughout the whole mass. A complete "batch" incorporating all the constituents can be made in from fifteen to thirty minutes. Each "batch" is now pressed between calender rollers, such as are used in the ordinary working of rubber, and need not be further alluded to. The "batch" then passes from the rollers on to to a drum placed in front of it, when the rollers on top of the drum force out any air globules which might have been entangled in the product during the mixing process. From the drum the "batch" passes off in a continuous sheet, and is deposited on flat cloth tables placed in front of the drum, the cloth being an endless cloth and carrying the sheets forward their whole length. These sheets are then cut any desired length.

The sheets thus cut are pressed between sheets of tin, when they are ready to be put into the vulcanizer. If the proportion of constituents is right for hard heveenoid, they are laid in cars which run on a track inside of the vulcanizer, sheets of paper are put between each layer, and the whole is covered with water to about six inches above the top layer. When the car has been moved into the vulcanizer, and the latter securely sealed, live steam is turned in, and left on for four and a half to five hours, when the product will be found completely vulcanized. Thirteen hours are required to vulcanize hard rubber by the old process, hence the saving of time is considerable. To make soft heveenoid, the sheets of the homogeneous mixture are pressed, as in the previous case, between sheets of tin, or pressed in moulds, which are afterwards put in the vulcanizer and covered with soapstone. When the vulcanizer is closed, it is heated by dry heat to about 312° F., and kept at this temperature for about forty-five minutes. If the product when taken out cannot be impressed by the nail, it may be considered sufficiently vulcanized.

The proportions of the constituents to make a soft and hard heveenoid may be approximately given as follows:

	Soft Heveenoid.	Hard Heveenoid.
Rubber	2 parts.	3 parts.
Camphor	2 "	2 "
Lime	$\frac{1}{16}$ "	—
Glycerine	—	$\frac{1}{8}$ "
Sulphur	½ "	8 "

Para is best for hard heveenoid, while Nicaragua rubber answers very well for soft heveenoid, and, in fact, is somewhat more adapted.

It is a well-known fact that sulphur will only combine to a very limited extent with rubber, only about one to three per cent. entering into chemical combination, the remainder of the sulphur added existing only in mechanical suspension. This fact is proved by two simple experiments—*first*, one or two per cent. of sulphur is sufficient to vulcanize with and produce the change; and *second*, if vulcanized rubber is ignited instead of burning with a steady, smoky flame, it throws off sparks of ignited sulphur, and if the flame be extinguished, the sulphur will be seen to solidify. The odor also of sulphurous acid is very marked. This is not the case with heveenoid; all the constituents of this new product are chemically united. The sulphur unites with the camphor, forming a sulphide of camphene, which either dissolves or is dissolved by the rubber; it seems, however, more probable that the former is the case. The efflorescence of sulphur, so noticeable in soft rubber, cannot take place in soft heveenoid, and when the heveenoid is ignited, it will burn with a smoky flame, and finally extinguish itself by depositing a coke over the ignited surface. If the same amount of sulphur were used in making heveenoid as is employed in making ordinary India-rubber, the product would not be properly vulcanized.

The amount of sulphur varying according to the proportion of camphor to India-rubber, a greater proportion of camphor to India-rubber requires more sulphur; in fact, the amount of sulphur required in any case is the amount necessary to form the sulphide of camphene. In the manufacture of hard heveenoid the same holds true that has just been stated about soft heveenoid: that more sulphur is required for the hard than for the soft. The temperature at which the constituents unite chemically is just above the melting point of camphor. In the manufacture of ordinary rubber, if too much sulphur is added, the product is hard and brittle. If such rubber be placed and left sufficiently long in molten camphor, it swells up and combines with the camphor, acquiring toughness and flexibility, and becomes a desirable material; in other words, it becomes heveenoid. Mr. Gerner has found that when a limited quantity of glycerine is added to the hard heveenoid mixture a very desirable product is obtained, the amount of glycerine depending on the proportion of rubber, augmenting as the percentage of rubber is increased—too much glycerine will, of course, deteriorate the product. All other substances used in the manufacture of ordinary rubber may be incorporated in the heveenoid mixture, and vulcanized, thus adapting it to every application that India-rubber is now used for in the arts.

The process of manufacturing heveenoid, is, of course, patented, the patent being held by the Heveenoid Manufacturing Co., of New York. At Hoboken, N. J., works are erected sufficiently large to make over three thousand pounds of stock a day. This company, however, only manufactures specialties, and sells licenses to other companies. The great consideration in favor of heveenoid is the fact that it can be manufactured and put on the market for about thirty to fifty per cent. cheaper than the ordinary vulcanized rubber.

The properties of good vulcanized rubber are:

1. Elasticity.
2. Pliability.
3. Durability.
4. Insolubility.
5. Unalterability by climate, or artificial heat or cold.
6. Inadhesiveness.
7. Impermeabilty to air, gases, and liquids.
8. Odor.
9. Plasticity.
10. Facility of receiving every style of printing.
11. Facility of being ornamented by painting, bronzing, gilding, japanning, and mixing with colors.
12. Non-electric quality.
13. Spreading quality.

A thorough investigation into the merits of heveenoid, which I have had occasion to make, developed the fact that heveenoid not only possesses the above mentioned properties of vulcanized India-rubber, but in many instances possesses them in an infinitely superior degree. As for example, heveenoid is far more pliable, durable, and insoluble than ordinary India-rubber. Being a chemical combination, it is less impermeable to air, gases, and liquids. As regards odor, it is far superior to vulcanized rubber, which, as is well known, possesses a very disagreeable, sulphur odor. Soft heveenoid smells of camphor, which renders it of great service as a moth and insect destroyer. Its application for lining of closets or wrapping of furs, etc., as also for submarine cables, opens a large field for it. Hard heveenoid, when rubbed or when warm, has a slight odor of camphor, but is not noticed unless under these conditions. The odor being pleasant, is much to be preferred to the old sulphur odor.

Heveenoid possesses a great value over rubber in the manufacture of jewelry, as the sulphur, being in chemical combination, permits of the use of poor as well as fine gold in ornamenting it. None but eighteen carat gold can be used with the ordinary vulcanized rubber, otherwise, owing to the free sulphur in its composition, the gold would change color. As regards coloring, heveenoid is far superior to rubber, as it may be colored any desired tint. This is something which the manufacturers of rubber have often attempted to do, but have utterly failed. As regards the spreading quality of heveenoid as compared with the vulcanized India-rubber used for the same purposes, heveenoid has a much greater spreading surface than India-rubber. If the India-rubber is made chemically pure, with only sulphur to vulcanize it, and then compared with heveenoid of equal purity, the spreading surface of both is about the same. But no such vulcanized rubber is suitable for the requirements of the arts, hence other foreign constituents are added, which reduce, of course, its spreading surface. As the specific gravity of India-rubber and camphor is practically about the same, rubber having a specific gravity varying from 0·920 to 0·962, and camphor 0·965 to 0·996, it might be expected of the pure vulcanized rubber and heveenoid that the spreading surface would be the same; but, as has just been stated, no such pure rubber is used in the arts.

The increase of spreading surface in favor of heveenoid speaks well for the economy of this new article of commerce.

Another property heveenoid possesses is the facility with which it can be sawed and designed. A saw may be used with heveenoid for from one-half to three-quarters of a day without being sharpened. The sharpening of saws in the working of ordinary vulcanized India-rubber is a matter of great expense, as they must be sharpened about every half hour. It is the friction of the saws against the uncombined sulphur in India-rubber which dulls them; the sulphur in heveenoid being in chemical combination, can offer no such frictional resistance.

The discovery of heveenoid will certainly give rubber and camphor a much wider application in the arts, as this new product is adapted for many new purposes where ordinary India-rubber would be useless. It seems strange that the combination of gum camphor with rubber had not been thought of before, especially when the fact is considered that Goodyear obtained his first patent in 1844, nearly forty years ago. The only way it can be accounted for is the fact that the India-rubber business has been a monopoly, and like most monopolies, original investigation in the line of improvements has been prosecuted only to a limited extent. The merits of heveenoid are such as to indicate an exceptionally profitable future, both as a benefit to the industrial arts and as a business of itself.

NOVELTIES IN A NOVEL LOCATION.

CLOSE under the Sierra Madre Mountains, a rugged, precipitous range thirteen miles east of Los Angeles, we were recently pleased to find a model machine shop, small in dimensions, but containing marchinery remarkable for its perfection. It is owned by Mr. J. C. Davis, and operated by J. K. Bigelow, late of San Francisco and formerly of the Springfield, Ill., watch factory. Here the models and working machinery are made for manufacturing Davis' new style of cigarettes. An upright tubular boiler and a two horse power engine supply the locomotion. A Pratt and Whitney lathe, a small planer, a bench lathe of hardened steel with numerous adjustable attachments for a variety of fine work and specialties, are among the equipments of this "gem of a workshop." It would be difficult to find more perfect machinery in any American metropolis than Mr. Bigelow completes with his own brain and hand work in this comparatively "out of the way" location. Mr. Davis calls his place Summer Hill—apropos to the fine climate. He owns 2,000 acres, principally mesa or gently sloping bench land. Its altitude places it in the warm or thermal belt, and notwithstanding the severe cold of the past winter, his ten-acre tract of tobacco, now partly in bloom, remains comparatively untouched by frost and steadily but slowly continues growing. The land is abundantly supplied with water for irrigating from the adjoining cañon. Oranges, lemons, and other tropical fruits grow unsurpassed here; most temperate fruits and vegetables also flourish.

Of tobacco, Mr. Davis grows only the fine Havana in variety, always from imported seed. His plants last the year round, during which period he makes several cuttings. He has an experienced Cuban tobacco-raiser. Sets his plants in March in rows about 4 feet apart; plants 15 inches; gathers his principal crops in July and September. Irrigates about once in ten days, during spring and summer months. Rates 600 to 700 pounds per acre a fair crop. He considers his soil as specially adapted to this culture, and that equally good land and facilities are limited in California. He has been seven years in bringing his cultivating and curing systems to their present perfection.

Mr. Davis' tobacco house is a well-constructed building 32x132 feet in size, and is at present well occupied with the crops of the past year, as he has but recently commenced selling it, and that in cigarettes only.

MACHINE MANUFACTURED CIGARETTES.

Mr. Davis is the only manufacturer, in America at least, of cigarettes wholly by machinery. The machine used is of his own invention, and is small enough to place in a lady's bandbox. It is simple in its operation, but too difficult for us to describe intelligently without engravings. Over 1,000 cigarettes can be made per hour by this machine. When finished one end of each cigarette is inserted in a wooden socket, a perfect mouth-piece, which enables the smoker to obtain the full smoking flavor of the tobacco without any disagreeable or deleterious taste of the natural leaf in the mouth. For this reason the "consumer" will expectorate less, thus adding to comfort and health. We tested samples and can testify to the excellent flavor of Mr. Davis' pure Havana cigarettes. He manufactures none others. We anticipate that his "Cerrito del Verano" will be the most popular brand of cigarettes in the United States, if not in all foreign countries. He intends soon to place them in the San Francisco market.—*Mining and Scientific Press.*

BOLETTE'S IMPROVED CONDENSER FOR WOOLEN YARNS.

By M. JEAN SEBASTIAN BOLETTE, of Pepinster, Belgium.

THIS invention of the single endless belt or strap seems to fill up a void, and bring to perfection this class of condensing machine. We have often painfully watched the working of the ordinary strap machine, and have witnessed the constant repetition of the effect caused by the slightest fault in the separate strap, either as to width, tension, or gripping power, whereas in M. Bolette's improved single, endless strap condenser the lap coming from the plain doffer of the carding engine is divided into slivers by means of a single endless leather strap for the entire machine, instead of separate straps for every sliver, and consequently any effect of variation in width through wear and tear, or any variation of smoothness of surface, or gripping power, between one portion of the strap and another is immediately distributed equally throughout every thread or sliver on the machine, thereby neutralizing any irregularity in size, and restoring the balance between thread and thread.

The makers of Bolette's improved condenser claim for it the following advantages, that "it is now ascertained that there is a great advantage in the use of plain doffer condensers. In the system of doffers covered with separate rings or ribbons of cards (filleting), there are spaces wasted, which cause the carding machines not to produce so much in the same width as they otherwise would.

"Among all the modes of dividing the laps coming from plain doffers that have been tried hitherto, the most practical ones are those which divide the lap by means of leather straps. They allow a machine of 50 inches to produce twenty threads more than if this machine were provided with a ring-doffer condenser.

"This dividing process is considerably improved by the invention of M. J. S. Bolette, which consists of making the division by means of a single endless leather strap, passed over and crossed between four rollers only, while the systems tried and used hitherto have required not less than ten rollers and a number of straps equal to the number of threads to be obtained.

"M. Bolette's invention is one of great simplicity, all its parts being easily seen, reached, and regulated. The threads, being all divided by the endless strap, are all formed in the most regular manner, the strap being constantly cleaned by a self-acting brush. One of the most important advantages of Bolette's improved condenser is the saving of the intermediate process of roving."

The drawings will illustrate the machine and its mode of working.

In our illustrations Fig. 1 is a side or end view, showing the new device fixed in position with reference to the doffer, X, and the rubbers, G, of a carding machine; Fig. 2 is a front elevation on a reduced scale, looking from the side of the doffer; Fig. 3 is a front elevation of same, also on a reduced scale, looking from the side of the rubbers. E is the leather endless band or strap in one piece; B and C the dividing rollers; DD the driving rollers; F are pulleys or carrying rollers; the fleece and slivers are shown in dotted lines. In action, the band or strap, E, is twisted in figure 8 fashion between the dividing and driving rollers, and touches on its way the rubber, G. The fleece passing between the dividing rollers is divided by the band or strap running in opposite directions, which takes two fleece ribbons, one downward and the other upward. These fleece ribbons are formed on the insides of the band or strap, but by the twisting of the said bands the ribbons come outside and in contact with the rubbers, by which they are taken and formed into slivers. This contrivance seems to be meeting with success on the continent, many large firms having already adopted it. We cannot learn, however, that any are at work in this country, and our opinion is, therefore, based on particulars and drawings supplied to us by M. Centner fils, Verviers (Belgium), who is the agent for the United Kingdom. With this explanation, we can say that we think the Bolette condenser by far the best of its class with which we are acquainted. It stands unrivaled, in our opinion, for some descriptions of work. We must, however, here remark that no good purpose is served by claiming for a machine more than its

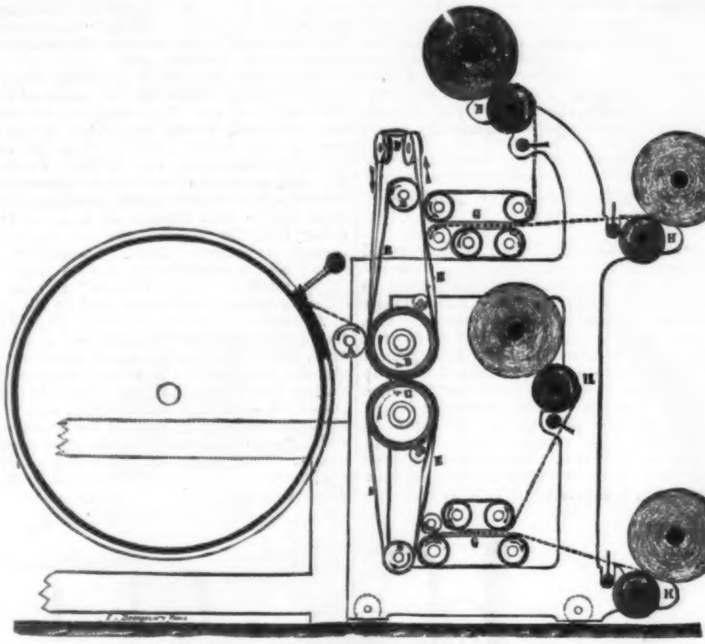


FIG. 1.—IMPROVED CONDENSER FOR WOOLEN YARNS.

nature warrants, as it will only compromise it in public estimation, and prevent its being used for work for which it is well competent. There is a very erroneous impression abroad among machinists that this, that, or the other condenser will do more work than another. The fact is that a condenser is an intermediate machine among a series of machines in a series of processes, and that it can only "stand its corner" and do the duties pertaining to it. We heard some time ago from an enthusiastic advocate of the Bolette condenser that it would produce twenty threads more work than could be produced by any ring-doffer machine. Now, the condenser has nothing to do whatever with the amount of work going through a set of carding engines. A very ordinary condenser of the ring-doffer kind will condense as much carded material as any set of carding engines can turn off. The condensing is simply a mode of doffing, and has nothing whatever to do with either the quantity or the quality of the carding process itself, strictly speaking. If a set of carding engines can be made to do more work, and to do it properly, the little doffing machine called a condenser

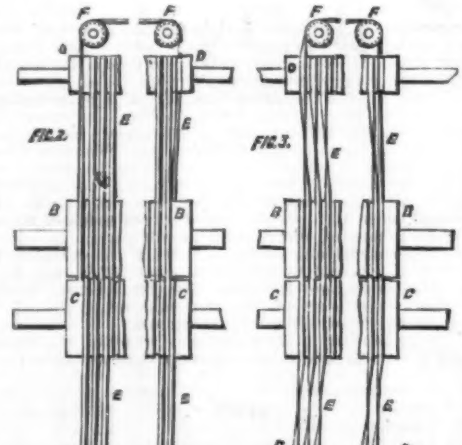


FIG. 2.

will be able easily and gracefully to bow its "good-by" to the carded material as it leaves the set of machines. More it cannot do, for the simple reason that more does not come within its reach. A great amount of condensing capacity is of no good unless it can be preceded by an equivalent amount of carding capacity. Let us moderate our statements, then, as to what this class or that class of condenser can do, and allow the condenser to occupy quietly its intermediate position and discharge its intermediate duties; and let us ask nothing more from it and expect nothing less.

Another claim put forth on behalf of this class of condenser, and one that is said to be one of its most important advantages, is that it saves the intermediate process of *roving*. Well, this may or may not be an advantage. There is such a thing as shortening processes too much, until they become inefficient and useless. The almost countless operations of drawing that come in as intermediate between the first and final operations of spinning in our textile trades, and which follow each other in apparently interminable succession, are there for a purpose, and the omission of any one of them would have a perceptible effect, and would vitiate the final result. If a fully-developed woolen yarn is the article wanted, then the intermediate process of roving can only be dispensed with at a sacrifice, as condensing to a very fine count leaves very little for the spinning section of the manufacture to do, and, as a consequence, we obtain only a partially-developed thread, there being not sufficient drawing room left to allow of the fibers being fully arranged so as to form a perfect or complete thread. We are not wildly to jump to the conclusion that all shortening of processes is gain; it may be far otherwise. But if a half-formed, half-developed thread is the article sought after, then it can be obtained by throwing away intermediate processes and shortening the others; but, on the other hand, should we be in search of a fully-developed, complete, and perfectly-formed yarn, then we can only obtain it by resorting to the intermediate process of roving, as certainly one operation of drawing (and that only a short one) cannot yield us the article we are in quest of. Persons using half-spun or partially-formed yarns wonder why the cloths made from them prove so unsatisfactory in *cover*, *handle*, and *strength*. Why? The reason is on the surface.

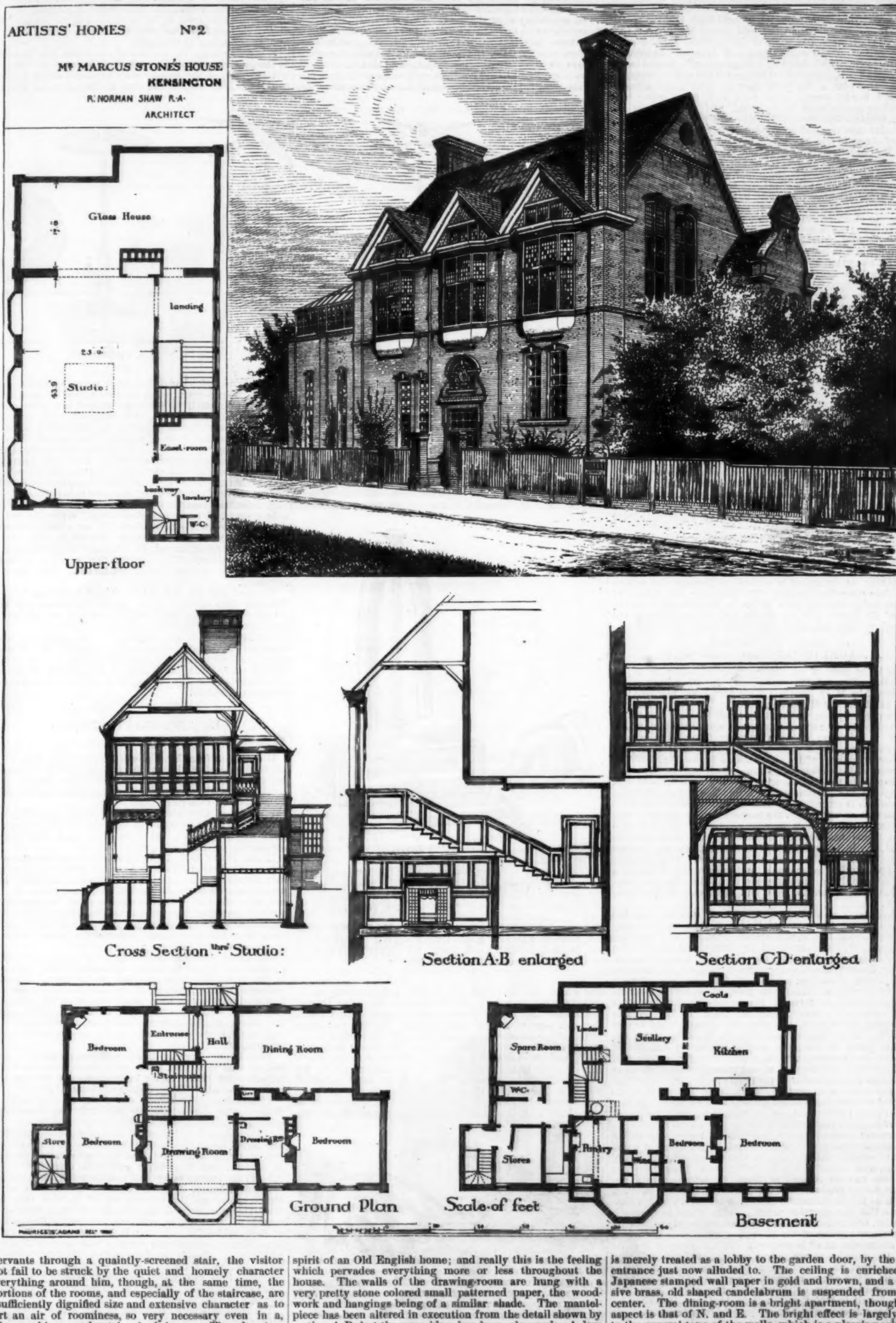
Another and further claim put forth on behalf of this class of machine for condensing is that it is well adapted for all kinds of wool. Now it is very obvious to a thoughtful observer that a long tethery wool would be extremely difficult to divide from the lap either by this machine or any other of its class, whether worked by one entire endless strap or by a series of endless straps, one for each ribbon. Obviously the only mode of dealing with such long wool is not to allow it to become interlaced into a web or lap, but to strip or doff it directly from the carding machine in ribbons by means of a ring-doffer. We not long ago examined some work as it was being condensed, and found some of the fibers of wool to measure 6 inches in length after passing through a large set of carding machines and the condenser. Clearly a long combing wool of this kind would be perfectly unmanageable if once allowed to form into a lap or web, and such wools are frequently used for clothing purposes in the fancy woolen districts of the United Kingdom.

Condensers of the class of the Bolette machine ought never to be set to work of this kind, as there is abundance of room for good machines like the Bolette condenser to be employed upon short, fine Saxony qualities of wool, in the working of which there is a brilliant future before it, in which it can attain a success equal to that which its preeminent merits unquestionably entitle it. We rejoice to see improvements in this class of condenser, or in any other class, as there is room for all and work for all, "each after its kind."—*Textile Manufacturer.*

ARTISTS' HOMES.—II.

MR. MARCUS STONE'S HOUSE, KENSINGTON.

IF it be true (and few will be bold enough to dispute the proposition) that an Englishman's house is, or should be, his castle, it by no means follows that the structural home itself should be built in the form of a machicolated stronghold, with lattices suggesting rather the necessities of defense than the prospect of hospitable welcome, which should be the distinguishing characteristics of every free-born citizen of the 19th century. Recently we illustrated the exterior appearance, and described, with the aid of a ground-plan, the 13th-century house in Melbury Road, Kensington, which Mr. William Burges has built for himself, and to-day we have taken our subject from over the way in the same road at Holland Park, and herewith illustrate the Queen Anne residence, with studio, erected by Mr. Norman Shaw for Mr. Marcus Stone, A.R.A. It would be difficult, perhaps, to find two buildings more unlike than these two, both in spirit and conception, unless it be the contrast which every one sees between Mr. Luke Fildes' house and its immediate neighbor, Mr. Burges' villa, just alluded to. Of Mr. Fildes' house, we may have an early occasion on which to remark more at length, and so to-day content ourselves by merely describing, in a few words, the subject of the sketches before us. The building, from basement to roof, is clearly illustrated by the plans and sections which the accompanying plate includes. From these it will be observed that the studio governs the planning of the house almost entirely, besides having determined, in a most emphatic way, its exterior architectural treatment, which, to all intents and purposes, is the outcome of the practical objects of the building. Entering from the street a spacious lobby, reached by



the servants through a quaintly-screened stair, the visitor cannot fail to be struck by the quiet and homely character of everything around him, though, at the same time, the proportions of the rooms, and especially of the staircase, are of a sufficiently dignified size and extensive character as to impart an air of roominess, so very necessary even in a, strictly speaking, moderately sized house. The drawing-room, being entered first, may be first described; and, indeed, the quaint arrangement of its recessed fireplace and barrel vaulted ceiling, with the picturesque location of the garden door through a curtained lobby, seem to give this room a primary interest. The low pitched alcove for the fireplace is obtained, as will be seen, by sections A B and C D, under the principal stairs and half space landings, and its effect in the room is thoroughly in keeping with the spirit of an Old English home; and really this is the feeling which pervades everything more or less throughout the house. The walls of the drawing-room are hung with a very pretty stone colored small patterned paper, the wood-work and hangings being of a similar shade. The mantel-piece has been altered in execution from the detail shown by section A B, but the same idea has been observed. A low proportioned gilt framed looking-glass over the mantel thoroughly agrees with Mr. Shaw's fireplace, the general effect of the whole being materially augmented by an admirable selection of Chippendale furniture and delicately tinted clayware, in the form of vases and plates, which the distinguished owner has brought together from time to time. The sanctity of the large bay is preserved from that constant intrusion which must necessarily occur when such a feature is merely treated as a lobby to the garden door, by the side entrance just now alluded to. The ceiling is enriched by Japanese stamped wall paper in gold and brown, and a massive brass, old shaped candelabrum is suspended from the center. The dining-room is a bright apartment, though the aspect is that of N. and E. The bright effect is largely due to the general tone of the walls, which is a pleasing salmon-red obtained really by a common lining paper, but with the most effective results. The ceiling is divided by beams into plain coffers, the cornices being richly moulded with boldly carved egg and tongue enrichments. The fireplace is a faithful reproduction in carton pierre, by Jackson & Sons, of an old Adams mantel, with admirable tiles in blue set within marble jambs and frieze. A lift is provided from the kitchen below, where are arranged the servants' hall,

pantry, store, scullery, and maids' bedrooms, in a sort of sub-basement. Mr. Stone's bedroom is shut off by a lobby next his dressing-room from the ground floor, and the spare bedrooms are reached from the half space landing of the principal staircase. The walls of the staircase form a well lighted gallery of old engravings and Japanese hangings, while the series of windows on a symmetrically shaped landing above affords many opportunities for ultimate decorative effects. Our plan at this point shows a returning handrail, but this is hardly correct, as no such well hole exists; but the landing is continued in its stead, and a useful set of presses forms a feature on this balustraded sort of gallery. The studio thus reached is unquestionably a splendid apartment of about 44 feet by 27 feet, beyond which a large glass house for outdoor lights and effects is obtained. This, like the studio, is heated by a series of hot water pipes, an open fireplace being obtained in the upper angle for the sake of that company which, to a silent and solitary worker, a cheering fire alone affords. The main lighting is from the three large oriel bays seen in our view, the two end lights being simply—in short—shams: not intentional shams, however, as we believe they were blocked up as being unnecessary, if not objectionable, for the practical purposes of painting. The oriels, it will be remembered, were designed by Mr. Shaw for execution in wood; but the district surveyor objecting on the strength of the M. B. Act, Mr. Lascelles, the builder of the house, offered to make the windows in concrete with the same mouldings and scantlings as before. This was agreed upon and executed; but we cannot say it has proved anything like a success, as the process of the crumbling away of the mullions is already assuming the form of a serious difficulty, which little short of reconstruction will probably overcome. Whether this is due to an imperfect mode of mixing the concrete, or a too early application of oil color before the concrete was thoroughly dry, must be difficult to determine now; but the way in which the joinery has shrunk and cast does not do the builder credit, and seems to suggest that to a similar want of care the failure of the concrete may be due. A top light is obtained by skylights, and when not required is shut off by means of balance hung flaps, as seen by our cross section through the studio. The woodwork of the studio is finished in white, any other color being, in the opinion of Mr. Stone, more than likely to influence the painter in the tone of his colorings in an injurious degree, while the brilliant bits of color obtained here and there in the old tapestry hangings with which the studio is surrounded, afford ample relief to the eye, and furnish a constantly changing series of effects for the mind to dwell upon.

An easel room adjoins the studio, having a high door for the taller easels to wheel in and out, and a back staircase is provided for the use of models, with a lavatory and water closet. Of the distinguished owner of this house we need say nothing, as our object is rather to describe the artist's home than the artist himself. The character and habits of the man being always, more or less, to be gathered from the style of his house, it is, no doubt, difficult to exclude the one inquiry from the other.—*Building News.*

A MAGNETO-ELECTRIC GYROSCOPE.

This is the name of an apparatus invented by M. W. de Fonvielle, editor of *Electricité*, after having witnessed an experiment by M. D. Lontin. This gyroscopic machine was lately exhibited by M. de Fonvielle to the Royal Society, when a paper by him was read by Prof. Stokes.

The object of the apparatus is to demonstrate new properties of induction currents brought into play in a magnetic field, and which give a continuous rotatory motion to movable pieces of iron of various forms (Fig. 1). The apparatus consists essentially of a galvanometric frame of any shape. In the first model which has been brought over to England the galvanometric frame is a rectangular one, above which is placed a horseshoe-magnet, supported by a vertical axis around which the magnet can be placed in any azimuthal position which may be required. The galvanometric frame has been so constructed that the horseshoe-magnet may be taken away and be replaced by any number of bar-magnets laid flat upon its upper side. It is possible also to place other bar-magnets underneath the frame in a space arranged for that purpose, or to place the two magnets laterally, or on the left and right side of the frame (Fig. 2).

To produce a continuous movement of rotation with the intervention of the magnets it is sufficient to place any movable piece of iron in equilibrium by means of a block on a vertical axis (Fig. 3) inside of the frame, and to send the current of induction into the coil. When, by means of a commutator, the direction of the primary is changed, the direction of the motion of rotation is reversed. The same phenomenon is observed when we transfer the poles of the acting magnets from left to right, or *vice versa*. But no sensible alteration even in the velocity is observed when we place the bar-magnets underneath which have been originally placed on the top, or *vice versa*. If the magnets are too near or too far from the rotating piece of iron, the motion ceases, which, under favorable circumstances, might acquire a very great velocity. The rotation is also stopped when the magnets are placed in a direction perpendicular to the frame.

The movable piece may be placed also at a small distance laterally without the rotation ceasing to take place. It may be also placed on the top, and be rotated by the influence of the bar-magnets placed underneath.

The same phenomena may be obtained very easily with a bar electro-magnet, of which one pole is presented at a distance of several meters. In this case the experiment is very curious, and looks like a conjuring trick, as two or three movables can be rotated at once. A mere change in the pole presented produces a change in the direction of rotation as well as the displacement from one side of the axis to another. But the operator must be careful not to approach too near, otherwise, the power of the electro-magnet being too great, the action of the induction current is absorbed, and no motion at all is observed. If the operator is quite near, the movable pieces of iron are attracted magnetically, and fly from the pivots, where they have been rotating, to the pole of the electro-magnet. To ascertain the velocity of the movable pieces of iron it is advisable to have them painted, half in white and half in black, so that they become gray as soon as the velocity is six or seven turns in a second.

It is possible also to obtain motion without the presence of magnets by giving an impulse to the movable by an exterior force, and M. de Fonvielle and M. Lontin insisted on that particular point in the memoir they have presented jointly to the Paris Academy in offering a theory of these curious phenomena. The rotation is not always the same, but once it is determined in a solid, sufficiently balanced, it continues indefinitely in the same direction. The direction does not change when we reverse the direction of the currents by means of a commutator.

The possibility of producing the same movement by means of movables of any form whatever, in presence of magnets or without their action, and notably of two spirals, constructed of a flat wire, and wound in an opposite direction, appears to the inventors to demonstrate that the rotatory action is exercised individually on each molecule of iron, and that the total impulse must be regarded as the integral of the

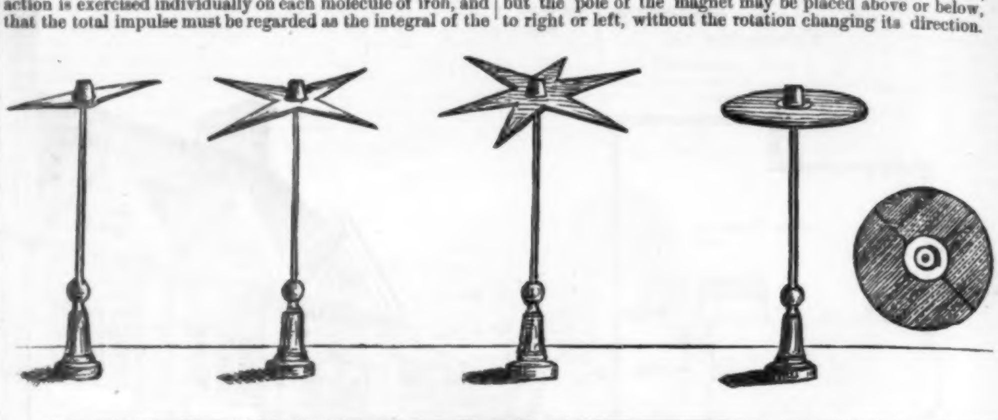


Fig. 1—SOME OF THE SOFT IRON ROTATORS USED IN THE GYROSCOPE.

individual impulsive actions. This remarkable property appears to furnish a very simple means of completely explaining all the circumstances of these curious phenomena by means of the known laws of induction, and to dispense with having recourse to any new hypothesis. It is sufficient, in fact, to remark that the molecule of iron acts in its movement of rotation in two different ways in each of the two nearly equal currents of induction which successively traverse the spires. In fact, during the whole continuance of the two phases of rotatory movement which the galvanometric frame brings closer together, each molecule of soft iron increases the intensity of the current which affects it,

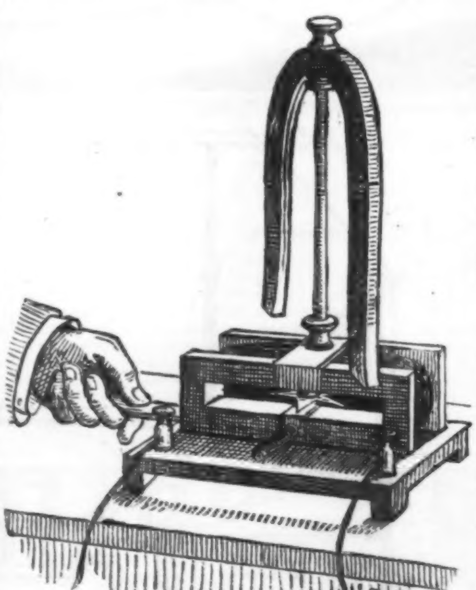


Fig. 2.—ROTATING INDUCTION MACHINE SURMOUNTED BY A MAGNET.—THE OPERATOR IS INTRODUCING A MAGNET INTO THE SPACE UNDERNEATH THE FRAME.

and which the inventors call *positive*, independently of its real direction, in order to fix the idea; at the same time it diminishes that of the current which repels it, and which they call *negative*, for the same reasons. In the two other phases of its movement the same molecule diminishes the intensity of the positive current, which then tends to draw it back, and increases that of the negative current, which turns it away from the frame. The actions exerted in the two phases of the movement, that is, in the total extent of the plane described by the molecules, tend then to keep up the continuous rotation, which progressively increases in speed until it reaches that which corresponds to the absolute

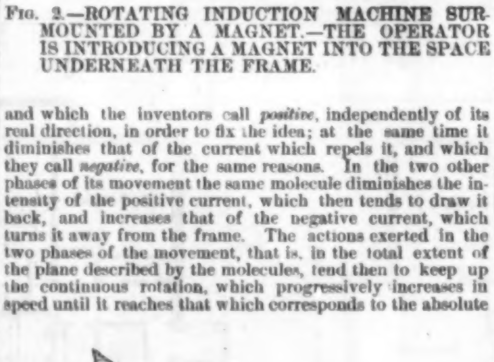


Fig. 3.—MOVABLE PIECE BALANCED ON ITS AXIS, READY TO BE INTRODUCED INTO THE GALVANOMETRIC FRAME.

intensity of the attractions or repulsions exercised by the currents induced, by the energy of the inductive current, the value of the friction of the resistance of the arc, etc.

When we bring the pole of a magnet into action, it is clear that its influence determines in each of the molecules of the movable object a transient magnetization, which strengthens the induction currents produced in the spires in the cases in which it is concordant, and which paralyzes them in the opposite case. It hence results that, in presence of a permanent magnetic center, the movement is possible only in a direction determined by its position and its nature. MM. de Fonvielle and Lontin believe that this principle applies even to the action of the earth.

When we change the position of the active pole in relation to the axis of rotation, the rotation changes its direction; but the pole of the magnet may be placed above or below, to right or left, without the rotation changing its direction. The two poles of a bar or horseshoe magnet combine to accelerate the movement when they are placed in the direction of the frame; but if we place the magnet in a perpendicular direction, all movement is, as a rule, rendered impossible. It is the same with near position; in proportion as we approach it to that limit of position, the rotation in general will be found to slacken. It is clear that a magnetizable body so strongly tempered as not to have the capacity of being magnetized and demagnetized to the given extent will remain insensible to these successive dynamic reactions, and consequently immovable, and that it is necessary to employ the softest possible iron in the construction of the movable objects. The same phenomena, especially with the spiral, may evidently be produced if we place it about the frame. They are accompanied, especially with the full disk, by a strident sound, by alternate magnetizations and demagnetizations. Their production appears to the inventors a new confirmation of the theories which they have advanced.

We must add that the coil used is of a peculiar construction, but that at least some of the phenomena can be observed without any Ruhmkorff's machine at all, but with an interrupter of the current from the battery.

It is impossible to say at present if the apparatus may be rendered serviceable as a motive power. But it may be used, at all events, not only as exhibiting a new mode of action, but as a balance to make a comparison of the force of several magnets, by placing them in opposition at various distances.—*Nature.*

EDISON'S ELECTRIC LIGHT.

To the Editor of the Scientific American:

It is evident from Mr. Upton's letter in your issue of May 15, 1880, page 308, that he is still unwilling to admit the incorrectness of the claims advanced in the original articles on Mr. Edison's machine, which appeared in your journal of October 18, 1879 (page 242).

I supposed that after pointing out the absurdity of the claims then made he would at least say nothing more in regard to that matter, but I see that such supposition is erroneous.

If Mr. Upton had simply published the reports of Professors Brackett and Young it would not have been necessary for me to refer again to the matter; but since he has seen fit to refer to the discussion in the manner he has, I am not disposed to allow him to deviate from the original issue without entering my protest against what I consider a flagrant attempt by a little jugglery of language to misconstrue the whole matter, and to convert a signal defeat into an apparent triumph.

Mr. Upton begins his letter by a comparison between the Siemens and Edison machines, to which I shall refer presently, and in the last paragraph but one he says: "I hope this statement will be sufficient to end the discussion into which I was drawn some time since regarding the efficiency of Mr. Edison's machine. He then claimed that nine-tenths of the power in the current could be made available; now tests show twelve-thirteenths of the energy in the current are available."

Now I am sure Mr. Upton will pardon me if I tell him frankly that this is not true. Is it possible that he can have forgotten the nature of the claims made, or does he simply realize their absurdity and desire to conceal the fact?

The claims Mr. Edison did make are set forth quite distinctly in the article, on page 242, and from which I quote the points to which I thus excepted:

"The internal resistance of the armature is only $\frac{1}{2}$ ohm, and Mr. Edison claims that he realizes 90 per cent. of the power applied to this machine in effective external current. It requires but five horse power to drive it." . . . "Now, the energy converted is distributed over the whole resistance; hence, if the resistance of the machine be represented by one and the exterior circuit by nine, then of the total energy converted nine-tenths will be useful, as it is outside of the machine, and one-tenth lost in the resistance of the machine." . . . "In Mr. Edison's generator five horse power is transferred upon a resistance of 5 ohms, of which a $\frac{1}{2}$ ohm is in the machine, thus delivering nine-tenths of the total current upon a circuit exterior to the machine; thus nearly the maximum economy is attained, when other machines under like circumstances will scarcely give any current at all."

The most superficial collation of Mr. Upton's last letter, with claims as given above, cannot fail to make it plain that Mr. Upton's construction of them is such as they will not bear.

The causes of loss of power in a dynamo-electric machine may be divided roughly into three classes, viz.:

1st. Loss of current energy in the wire on the machine itself, which is due simply to the resistance of the wire, and which is commonly called "internal resistance," or "resistance of the machine."

2d. Loss of power by currents induced in the masses of metal composing the machine, and which appears as heat in the machine.

3d. Loss due to friction of journals, brushes, spark at commutator, inertia of mass or masses of metal forming the armature, etc., etc.

In the article, page 242, no notice is taken of the second and third causes of loss, which in some machines is very great, and is quite large in all the known forms. On the contrary, it is distinctly stated that 90 per cent. of the *power applied* to the machine *is available* in the external circuit, and, since the resistance of the machine is as one to ten, the other 10 per cent. appears as heat in *the wire* of the machine, and is, therefore, practically lost. There is thus no escaping the conclusion that, if the claims made on page 242 were true, Mr. Edison has discovered some new law of the electric circuit, or resistance is not resistance in the currents induced in the Edison machine, or that what, after all, is substantially the same thing, Mr Edison has discovered something more than perpetual motion.

Otherwise, how could he manage to get 90 per cent. of the power applied to the machine in the external circuit, unless the machine, when once started, would furnish power enough to overcome the losses due to causes 2 and 3?

But since "power applied to the machine" fairly includes also (in Mr. Edison's machine, as in some other machines) the power necessary to drive the machine to furnish the current to excite the field magnets, it is evident that it must be not only capable of running itself, but of furnishing power to drive the other machine. Should Mr. Upton claim that this was not considered in the original article, then I say that it was unfair to compare the Edison machine with other machines in which the power necessary for the purpose had been fully taken into consideration.

Having thus briefly called attention to the points in dispute, I now desire to point out that, even *with the new machine*, from which, as stated by Mr. Upton himself, much higher results were to be obtained (see Mr. Upton's letter in SCIENTIFIC AMERICAN for November 29, 1879, page 337), he is still unable to obtain the results stated; for if we concede the correctness of Professors Brackett and Young's report, so far as it goes, the loss in the second machine is 17 per cent.; and notwithstanding the report of Professors Brackett and Young, we are still left without the facts necessary to ascertain the efficiency of Edison's machine, and, in the absence of the missing element, I should consider it highly improper to compare its performance with that of the Siemens or that of any other machine. For although the *current in the circuit* of the field magnet is taken into consideration, yet the power taken to drive the machine to furnish that current is not stated.

Since, in the comparison with the Siemens machine, Mr. Upton has taken the liberty to introduce a correction for the difference between the commonly-accepted value of the electro-motive force of the Daniell cell and that given by Dr. Hopkinson, I think it not impertinent to ask, why did he not take the same pains to introduce a correction in regard to the power used to drive the first machine?

Again (with all due respect to Professors Young and Brackett), the difference between the calorimeter test and the galvanometer indications is quite large, and, from the behavior of the dynamometer, I should scarcely be willing to accept the results as anything more than a fair approximation to the truth.

In Mr. Upton's letter no account is taken of these facts. The only object he appears to have in view being to reduce the efficiency of the Siemens machine to the lowest point possible by all the means in his power, and to exalt the apparent efficiency of Mr. Edison's machine, at the expense of the Siemens, as is pretty clearly shown, when we bear in mind that the Siemens machine, to which Mr. Upton refers, is but a fraction of the weight of Mr. Edison's machine, being only about 400 lb.; while the Edison generator is nearly, if not quite, 2,000 lb., yet the Siemens machine generates nearly as much current (more with the same resistance in the external circuit) as the Edison. It would be about as fair to compare the absolute efficiency of the two machines as it would be to compare the absolute efficiency of an ordinary 5 horse power steam engine with one of Corliss 100 horse power.

In the last paragraph of his letter Mr. Upton has again referred to his favorite hobby, viz., the "internal resistance of the machine."

Whatever is "childish" about the matter is made doubly so by Mr. Upton's remarks. It is quite evident he does not understand the affair at all, or is so anxious to defend the statements of page 242 as to catch at the feeblest straw that seems to float in his direction. Now I say that, whether the resistance of that armature be one-eighth of an ohm or 100 ohms, it makes no difference. It is simply a question of the ratio of the internal resistance of the machine to that of the external circuit. For, other things being equal, it is perfectly immaterial what the resistance is, so long as the ratio is observed. I express this view with a full knowledge of that remarkable statement on page 242, which I quote:

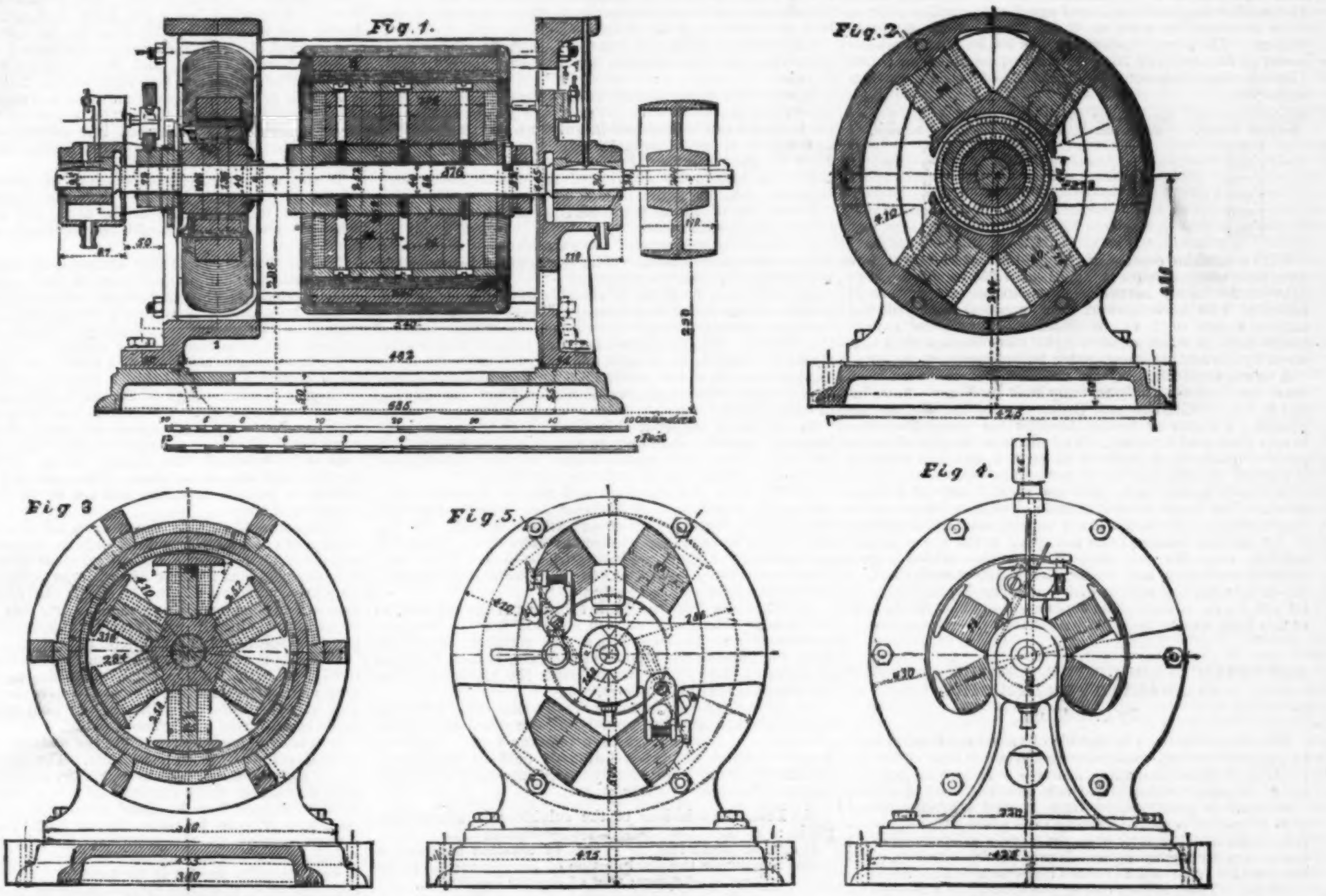
"The Siemens machine, and nearly all other machines in use, make the external resistance equal to that of the machine; hence one-half of the energy only is useful, and any attempt by these inventors to increase the exterior resistance, so as to change the distribution of energy to obtain more exterior work, results in reducing the power of the machine to convert energy. Therefore efforts toward economy in one direction are met in the other direction by loss in the interest account due to the necessity of using a greater number of machines to convert a given amount of power."

Did it never occur to Mr. Upton that other inventors could do just what Mr. Edison has done—*make their machines larger* instead of *making more of them?* EDWARD WESTON.

Newark, N. J., May 21, 1880.

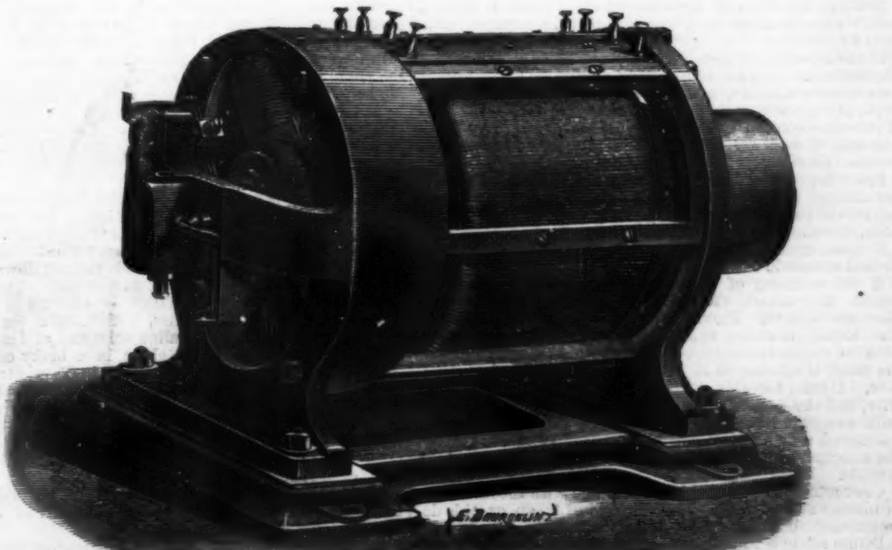
GRAMME'S COMBINED DYNAMO-ELECTRIC MACHINE.

WE reproduce, from our contemporary *La Revue Industrielle*, illustrations of a new form of dynamo-electric machine, which has been recently introduced by M. Gramme. The machine differs considerably from the Gramme machine brought out in 1878, both in the greater amount of light it is capable of producing per horse power and in its lower first cost.



THE GRAMME COMBINED EXCITING AND DIVIDING MACHINE FOR THE ELECTRIC LIGHT.

By reference to the engravings it will be seen that the arrangement of the machine is as follows: On a cast-iron foundation are fixed two plates of the same metal, almost circular, connected together by six square bolts and provided with bearings for the main shaft. One of these plates is furnished on the inner side with a circular rib on which are mounted the electro-magnets of the exciting apparatus. As in the earliest models the coil for the alternating currents rests on the square bolts connecting the end plates with packing pieces of hard wood. The six movable electro-magnets are fixed radially around a hexagonal sleeve which



THE GRAMME COMBINED EXCITING AND DIVIDING MACHINE FOR THE ELECTRIC LIGHT.

is bolted to the shaft. The armatures are held by the same screw as shown in the longitudinal section. The shaft carries on one side the small exciting coil, and on the other the induction coil. The bearings are wide, and in the larger machines a system of automatic lubrication is employed.

An arm carrying a wire brush, shown in the section, Fig. 1, serves to place in communication the coils of the moving electro-magnets with the exciting circuit. The current is collected and transmitted by small brushes of silvered copper wire. The brushes are moved by means of a small endless screw. For regulating the power of the machine a copper wire, the length of which can be varied at will, is introduced between the excitor and the electro-magnets. The method of coiling the wire differs slightly from that adopted in the other machines, as instead of winding one wire two are coiled, in order to obtain by this mode of coupling tension currents for small lights, or quantity currents for large ones. Two types of this machine are now manufactured. The smaller weighs 616 lb., and supplies 12 candles of from 20 to 30 Carcel burners, or 8 candles of from 40 to 50 burners. The larger machine weighs 990 lb., and furnishes power of 24 candles of 20 to 30 burners, or 16 of 40 to 50. The following table contains the results of some recent experiments:

Number of Revolutions per Minute.	Horse Power Expended.	Number of Lamps.	Power of each Light in Carcel Burners.
1,400	5	12	28·5
1,425	6	8	43·0
1,200	4	6	48·5
1,000	13	16	48·0
1,020	13	16	51·5
1,200	14	24	31·0

With a machine especially arranged for small lights, there have been obtained with a speed of 1,250 revolutions 14 lights of 20 Carcel burners each, with an expenditure of power of 4·66 horse power. The candles employed had carbons 3 mm. (0·12 in.) in diameter. In all the experiments made a much steadier light was obtained than that given by the machines employing an independent excitor.

A recent application of this machine has been made on board the Cosmos, a ship recently built by Messrs. A. J. Inglis & Co., of Glasgow and Greenock, for the Messageries Fluviales à Vapor in South America for running on the Rivers Plate and Uruguay. The machine employed is capable of producing 8 small or 12 large lights, and running at a speed of 1,500 revolutions per minute maintains 8 lights of 50 Carcel power each, with an expenditure of 6 horse power. The lights are distributed as follows: Three in the upper saloon, three in the lower saloon, one on the landing of the stairway leading from the upper to the lower saloon, and one over the gangway. The machine, which is fixed on deck amidships and under the paddle-wheel shaft, is driven by a vertical engine with a cylinder 4½ in. in diameter and 4½ in. stroke. The experience obtained at the trial of this light was in every way satisfactory.—*Engineering.*

THE APPLICATION OF THE ELECTRIC CURRENT IN ANALYTICAL CHEMISTRY.

By C. LUCKOW.

THE electric current is capable of varied application both in quantitative and qualitative analysis. It can effect the solution of metals and alloys at the + pole, and the precipitation of certain metals from acid solutions, and of others from alkaline solutions, or from neutral solutions mixed with acetate of soda. This may take place either at the — pole in the metallic state or at the + pole as peroxide. It also serves for separating metals precipitable out of an alkaline solution from such as cannot be thrown down from such solutions. Thus, copper can be precipitated as a metal, and lead as peroxide, being simultaneously separated both from each other and from all the metals of the first four groups, except manganese. The author recommends Meidinger's battery as giving a constant current for two or three months, and as constantly available, and points out many advantages of the electric separation of metals as compared with ordinary analytical processes. A Meidinger battery of four elements costs about £1, and consumes yearly 25 lb. sulphate of copper. In acid solutions the electric current has a reducing action, but in alkaline solutions it is an oxidizer. If a current is passed through solutions of the compounds of chlorine, bromine, iodine, cyanogen, ferro and ferri cyanogen with hydrogen, the above-named electro-negative constituents are separated out at the + pole and the hydrogen at the — pole.

Cyanogen undergoes a further decomposition, the final products being carbonic acid and nitrogen. The solutions of ferro and ferri cyanogen deposit Prussian blue at the + pole.

In dilute solutions of metallic chlorides there is formed merely hypochlorous acid, accompanied in stronger solutions by chlorine.

In the solutions of the chlorides of the alkaline and earthy alkaline metals a chlorate is formed as soon as the solutions have become alkaline, in consequence of the escape of the hypochlorous acid and of the chlorine. If dilute solutions of chlorides contain little free hydrochloric acid hypochlorous acid alone is formed, and the liquid in course of time becomes alkaline.

From the solutions of the iodides and bromides iodine and bromine are deposited at the + pole, and in case of the metals of the two first groups, especially in concentrated solutions, there are formed iodates and bromates.

Potassic cyanide is decomposed by the current into potassic and ammonic carbonates.

If the solutions of the chlorides, iodides, and bromides contain free alkali, the chlorates, iodates, and bromates alone are formed. From the insoluble compounds of chlorine, iodine, bromine, cyanogen, ferro and ferri cyanogen with the metals in presence of dilute sulphuric or nitric acid, the metal is eliminated at the — and the halogen at the + pole. Hence, for this purpose the — pole is a platinum wire, and the + pole a platinum capsule, in which the metallic compound before the addition of the diluted acid is moistened with a little water, which is evaporated to prevent the adhesion of the metallic compound to the bottom of the capsule.

Concentrated nitric acid is decomposed with the formation of nitrous acid at the — pole. In acid of 1·2 sp. gr. this decomposition does not ensue, at least with a weak current.

Dilute nitric acid between two platinum poles passes into ammonia neither when alone nor in the presence of sulphuric acid. But if dilute nitric acid is mixed with a solution of copper sulphate and submitted to electrolysis, metallic copper is deposited and ammonic sulphate is formed, all the nitric acid present being thus transformed, if there is sufficient copper salt. Ammonia is also formed in the electrolysis of nitrates, except a free alkali is present.

Concentrated sulphuric acid is decomposed with separation of sulphur, but the dilute acid is not, nor is the acid decomposed during the electrolysis of the aqueous solutions of its salts.

Sulphurous acid in aqueous solution is resolved into sulphur and sulphureted hydrogen; in its salts it is gradually converted into sulphuric acid. The hyposulphites gradually pass into the corresponding sulphates, with separation of sulphur.

The alkaline sulphides are decomposed with or without liberation of sulphur according to the proportion which they contain, and a sulphate is simultaneously formed.

In the solutions of the alkaline sulphites and hyposulphites there is a transitory formation of polythionates along with the production of sulphides.

Phosphoric acid is not decomposed by the current, whether in dilute solution or in the dilute solutions of its salts.

Carbonic acid is very incompletely liberated at the + pole from the solutions of the bicarbonates.

Silicic acid is separated from concentrated solutions as a white mass, and boric acid in dendritic crystals, both at the + pole.

In order to separate the above-mentioned acids from their insoluble compounds with the metals of groups 4, 5, and 6, the insoluble salt is dissolved in sulphuric or nitric acid, in an alkali or in some suitable salt, or we proceed as laid down for the insoluble chlorides.

We now turn to the behavior of the electro-positive constituents under the action of the current.

The metals of group 6 are all separated from their solutions in the reguline state.

(1.) From the solutions of the chlorides also, in presence of free hydrochloric acid, which, if abundant, is neutralized with ammonia, there are separated—

(*a.*) Antimony from the trichloride or the chlorine compound corresponding to antimony oxide as a dark brown or light gray metallic deposit according to the concentration of the solution. The precipitate is hardly soluble in hydrochloric acid, readily in nitric acid, especially if previously moistened with hydrochloric acid. Antimony is easily and completely thrown down in a reguline state from the solution of emetic tartar.

(*b.*) Arsenic from the trichloride, as dark brown or black graphitic deposit, according to concentration, insoluble in hot hydrochloric acid, readily soluble in concentrated nitric acid and in a solution of sodic hypochlorite.

(*c.*) Tin from the stannous and stannic chlorides as a white deposit with a dull metallic luster, easily soluble in dilute acids, especially in contact with platinum. In the electrolysis of arsenic and antimony chlorides some arsenic and antimony hydride escapes at the — pole. If all these three metals are present simultaneously, arsenic is deposited first, then antimony, and lastly tin.

(*d.*) Platinum from the dilute solutions of the chloride, to which some solution of sodium chloride may be advantageously added. The deposit is at first reguline; afterward, when the solution has become very dilute, it takes the form of platinum black. The deposit from the insoluble double chlorides takes the latter form.

(*e.*) *Gold*, like platinum, is easily deposited from its soluble and insoluble compounds. From solutions in potassic cyanide it is deposited in a reguline form. Platinum vessels in which the precipitation of gold or platinum is conducted should be previously coated internally with a thin stratum of copper or silver.

(2.) From the solutions of the sulphides in alkaline sulphides:

If care be taken that an excess of alkaline sulphide remains in solution the precipitation of arsenic and tin in the metallic form is complete; that of arsenic incomplete.

(3.) From alkaline solutions:

Stannic and antimonic acids dissolve readily in concentrated soda or potassa lye from which metallic deposits are obtained. The precipitation is very imperfect, and is only rendered complete by the introduction of sulphureted hydrogen into the alkaline solution, or its acidulation with hydrochloric acid.

Of the metals of group 5, the current throws down:

(*a.*) Copper completely from solutions containing free sulphuric, nitric, or acetic acid, provided the weight of such free acid, calculated as anhydride, does not exceed eight per cent. of the weight of the solution. If the solutions contain some free hydrochloric acid all the copper is thrown down) if sal-ammoniac, common salt, or sodic acetate be added. If ammonia, ammonic carbonate, or potassic cyanide is added to the solutions of neutral copper salts, all the copper is thrown down as a metal.

(*b.*) Silver, from solutions containing not above eight to ten per cent. of free nitric acid, is deposited in a very bulky metallic state. Some peroxide is also deposited at the + pole, the formation of which is prevented by the addition of a little glycerin, milk sugar, or tartaric acid. From the solutions of silver salts in ammonia or ammonic carbonate, the metal is also thrown down in a very bulky form, peroxide being separated out at the + pole, but it is soon reduced to metallic silver. If potassic cyanide is added to neutral or ammoniacal solutions of silver, or if silver-salts, insoluble in water, are dissolved in potassic cyanide, the silver is deposited from such solutions in the reguline form with a dull metallic luster.

(*c.*) Mercury is completely deposited in the form of drops from mercurous and mercuric solutions. The metal is also readily separated from its insoluble compounds. If other metals are also present, amalgams are formed.

(*d.*) Lead from neutral solutions is thrown down partly at the — pole as metal, and partly as peroxide at the + pole. A complete metallic precipitation is effected only in presence of easily oxidizable bodies, which hinder the formation of peroxide. From the alkaline solutions of lead, the current precipitates the metal alone in a bulky condition, a slight deposit of peroxide at the + pole disappearing in the sequel. The complete separation of lead as peroxide is effected in a pure solution of lead only in the presence of more than ten per cent. of pure nitric acid. If the solution contains copper also, then even in presence of small proportions of nitric acid, all the lead is deposited at the + pole, even though small quantities only of copper were present in solution. Other metals, such as silver and mercury, behave in a similar manner, but include part of the lead in their metallic precipitates.

(*e.*) Bismuth is thrown down in the reguline form from solutions containing some free nitric acid, a little peroxide being deposited at the positive pole. The metal is easily separated as a black mass from the insoluble compounds of bismuth.

(*f.*) Cadmium is completely deposited from the dilute neutral solutions of its sulphate, nitrate, and acetate in the metallic state with a zinc-gray color. The quantity of the acid liberated in the solution of the sulphate may rise to one and a half to two per cent. before the precipitation of the cadmium is hindered. It is also completely deposited from solutions which have been mixed with an excess of ammonia or ammonic acetate.

If all the above-named metals of group 5 are present together in a solution containing free nitric acid, mercury and silver are thrown down first, and copper and bismuth not until the greater proportion of the two former metals has been precipitated.

Of the metals of group 4, zinc, nickel, and cobalt are imperfectly precipitated from the solutions of their neutral sulphates, but manganese and uranium are not thrown down at all in a metallic form. If, however, such solutions are mixed with a solution of an alkaline acetate, tartrate, or citrate, zinc, nickel, and cobalt are completely precipitated, and uranium to a small extent. The metallic zinc deposited from such solutions has a gray color, and usually a metallic luster, and is readily soluble in acids and alkalies. Nickel is deposited of a yellowish gray, and cobalt of a reddish gray color and metallic luster, and both dissolve with difficulty in cold dilute sulphuric and nitric acids. The original reddish color of the cobalt solution turns to a dark brown soon after the current begins to operate; a part of the cobaltous oxide is transiently converted into cobaltic oxide. From solutions containing all the three metals the zinc is deposited first.

During the electrolysis of solutions of neutral sulphates of the above metals hydrates are soon formed, in consequence of the conversion of the nitric acid into ammonia, whence such solutions should be previously acidified with acetic acid.

On the electrolysis of the ammoniacal solutions of the above metals, and of the solutions of their cyanides in potassic cyanide, all three metals are completely deposited.

Zinc may also be completely precipitated in a reguline state from the potassic solutions, to which a little potassic cyanide may be advantageously added.

On dissolving in acids the zinc which has been deposited upon platinum, there generally remains upon the latter a dark gray coating, rough to the touch, and not soluble even in concentrated acids. On ignition it shows a play of colors which, on subsequent treatment of acids, disappear, while some zinc is dissolved. Sometimes it is not practicable to remove the whole of this deposit except by the action of melting acid potassic sulphate. This coating is formed very slightly in potassic solutions, and not at all in the nitrate solutions of zinc.

Manganese is thrown down from its solutions, whether neutral or containing free acid, only as hydrated peroxide, and not at all as a metal. If it is desired that the manganese deposit should adhere firmly to the positive surface the proportion of free acid must be small. In very dilute manganese solutions, containing much nitric acid or a mixture of nitric and sulphuric acid, permanganic acid is formed, and gives the solution a characteristic red color.

Uranium is deposited even from perfectly neutral solutions of its oxide only in small quantities and as a yellow-gray metallic precipitate, which dissolves in hydrochloric acid with liberation of hydrogen. In acid solutions uranic oxide is converted into uranous oxide.

Iron is completely deposited in the metallic state from the neutral solutions of ferrous salts. The ferrous oxide is partly converted into ferrous oxide in consequence of the oxidizing action of the current. If to a neutral solution of ferrous sulphate there is added a solution of ammonic citrate, and if care is taken that a little free citric acid always remains in the solution, the iron is completely thrown down in a shining reguline form, even if a part of it was originally present in the form of a ferric salt. Iron thus deposited resembles bright platinum, but to preserve its luster, it must be washed first in water, then in alcohol, and dried quickly.

From potassic ferrocyanide no metallic iron is precipitated, but Prussian blue at the — pole.

From the solution of ferrous oxide in sodic hyposulphite all the iron is deposited, chiefly as sulphide.

Metallic iron of a blue-gray color is deposited from the solution of ferrous fluoride in sodic fluoride.

The solutions of the metals of the three first groups present little that is characteristic on the transit of an electric current. If the two poles are arranged separately in the limbs of a U-tube filled with such solutions, the hydrates of the metallic oxides appear at the — pole; chromic oxide and aluminic hydrate in a voluminous form; calcic and magnesic hydrates as white incrustations; baric, strontic, potassic, and sodic hydrates in a soluble form.

In the solutions of baric and strontic salts there appear white turbidities on the surface, in consequence of the formation of carbonates.—*Zeitschrit für Analytische Chemie.*

TULARE LAKE WATER ALKALINE.

PROF. HILGARD informs us that since his announcement, at the December meeting of the Horticultural Society, of the alkaline quality of Tulare lake water, he has accurately determined the matter in solution in the water, and finds it far more alkaline than preliminary tests led him to suppose. He finds now that there are 84 grains of mineral salts dissolved in each U. S. standard gallon of water, and that 31 grains are carbonate of soda, the balance being chiefly common salt and Glauber salts. In potable well water the largest amount of mineral salts is about 15 grains to the gallon, and in ordinary river water from 8 to 12 grains is the highest. Thus it appears that in Tulare lake water there is not only six or seven times as much mineral matter in solution as in well or river water, but the matter is wholly different in the lake water, being in great part of caustic alkaline character and destructive to plant life. This water, although its alkaline salts could be neutralized by the use of gypsum, would require large amounts of the latter, say about 150 pounds of gypsum for every inch depth of water put upon an acre, or 1,500 pounds per acre, if ten inches of water were applied to irrigation. Even with this treatment it would not do to put on so much water and allow it to evaporate from the surface because of the deposits of salts which would take place, and even with the remedy suggested there would have to be drainage planned, and perhaps more water applied to wash out the objectionable matter from the soil. Thus it clearly appears that there are chemical as well as engineering problems to be considered in irrigation schemes, and it is fortunate that the College of Agriculture has called attention to the Tulare lake water before the public money was devoted to carrying out an enterprise which might be a triumph from an engineering point of view, and yet worse than useless to the agriculture of the region. Of course we do not say that this would ultimately be the case

if the west side scheme were carried out, for the rivers emptying into the lake may be wholesome, and the alkaline supply of the lake be guarded against. But this and all correlative points must yet be determined, and it is plain that the inquiry must take a wider range than heretofore supposed before the investment on the part of the public can be considered a safe one.—*Pacific Rural Press.*

GAS AND GAS MAKING.*—IV.

By L. P GRATACAP, Ph.B.

THE PRODUCT.

ILLUMINATING gas is a mixture of gases whose separate percentages in the whole vary with the material used, and the degree of perfection to which the process practically attains. We are considering gas made by the destructive distillation of coal, and no modification of this process, as coal gas mingled with oil gas, or any novel practice, as water gas. These are reserved for separate treatment.

The ordinary constituents of coal gas and their quantitative relations are shown in the following selected analyses.

Dr. Kidder's theoretical composition:

Hydrogen	44 to 48
Marsh gas	34 " 38
Carbonic oxide	5 " 7
Carbonic acid	1 " 3
Air	1 " 3
Water, temperature 40° to 60° F.	1 " 3
Hydrocarbons	6 " 10

CANNEL COALS.

	Manchester Gas.	Rochdale Gas.	London Gas.
Hydrogen	45·58	53·44	35·94
Marsh gas	34·90	29·87	41·99
Carbonic oxide	6·64	5·86	10·07
Carbonic acid	3·67	——	1·19
Oxygen	——	——	——
Nitrogen	2·46	——	——
Hydrocarbons	6·46	10·83	10·81
Sulphureted hydrogen	0·29	——	——

BITUMINOUS COALS.

	London Gas.	
Hydrogen	50·05	-51·24
Marsh gas	32·87	35·28
Carbonic oxide	12·89	7·40
Carbonic acid	0·32	0·28
Oxygen	——	——
Nitrogen	——	2·24
Hydrocarbons	3·87	3·56

WESTMORELAND COAL ENRICHED WITH ALBERTITE, NEW HAVEN, 1869.

Hydrogen	42·47
Marsh gas	46·16
Carbonic oxide	2·08
Carbonic acid	——
Air	2·68
Hydrocarbons	6·67

HEIDELBERG GAS.

Hydrogen	44	46·2
Marsh gas	38·4	34·02
Carbonic oxide	5·73	8·88
Carbonic acid	4·23	3·01
Oxygen	0·37	0·65
Nitrogen	——	2·15
Hydrocarbons	7·27	5·09

BOSTON GASLIGHT CO.

Hydrogen	43·15
Marsh gas	42·97
Carbonic oxide	6·06
Carbonic acid	0·35
Oxygen	0·13
Nitrogen	2·05
Hydrocarbons	5·29

In addition to these ingredients, obscure compounds of sulphur with bisulphide of carbon and ammonia salts are found in the gas, and may in large quantities prove highly objectionable and mischievous. Illuminating gas is therefore composed, first, of a series of non-illuminating but highly combustible gases, which together form a burning fluid whose sole office is the supply of heat; second, a group of hydrocarbon gases, yielding upon combustion more or less light; third, diluents whose influence is deleterious directly proportional to the percentage present; fourth, impurities.

The first group consists of hydrogen, marsh gas, and carbonic oxide, and upon the proportions of these bodies present in the gas depend some important features. They regulate the degree of heat which the gas attains in burning, and they determine its density in a great measure. Hydrogen, the lightest gas known, possesses the highest calorific power, and while it assists the buoyancy and vitality of the gas, produces upon combustion a high temperature which, as we subsequently see, is essential to the purest and whitest light. Its gravity compared with air is 0·693, its calorific power 34,462 units, and its calorific intensity is 2,746° C., the latter falling so much below the former since hydrogen in burning unites with the oxygen of the air, which supports its combustion and forms aqueous vapor, and a certain amount of heat is abstracted from the sum total of heat generated in order to raise the temperature of the water produced.

Hydrogen from its calorific power is pre-eminently valuable in gas, and its percentage in normal coal gas should exceed that of any other constituent. Not that it may not predominate so as to virtually destroy or effectively diminish the luminosity of the gas, but that within reasonable limits it enables the engineer to utilize his illuminating material in the best way. The principle underlying this is the much-discussed, some time discarded, and recently rehabilitated doctrine of photogeny propounded by Sir Humphry Davy. This philosopher insisted that the luminosity of a gas flame was due to the presence in infinite numbers, confined to the luminous zone, of solid points of carbon which became incandescent at high heats. So far as gas flames are concerned this is unquestionably true, and the appearance of soot upon a cold object pressed into a flame, the opacity of the flame itself, at least of its light-giving portions, and the ease with which a non-luminous flame can be made luminous by the introduction into it of coal dust, all point, and, so far as it is a practical question, establish the reality of this theory. Granting this position, there is very evidently a proper proportion to be maintained between the heat produced by combustion of a gas flame and the number of carbon points to be raised to whiteness by that heat. This heat may be obtained by the intimate mixture of oxygen with the flame, and by a large proportion of hydrogen and highly heating bodies which upon burning produce the necessary temperature. The significant conclusions to be drawn from this will be shown further on. It only here indicates the indispensable service rendered by hydrogen in the economy of illumination. Hydrogen, while it thus, *par excellence*, renders the flame a hot one, imparts lightness to the gas, which permits the engineers to use a reduced pressure for its distribution. Hydrogen, as the lightest body, known, diffuses with great rapidity, and a change in the constitution of the gas may take place in long transits from its escape through crevices and minute apertures, and this quite independently of its associates in the gaseous mixture which, although they suffer transfusion, do so in relatively smaller volumes as their density is greater. The well known experiments of Dobereiner and Graham upon the diffusion of gases showed that through the finest cracks in the walls of a vessel, even though pressure was exerted by the confined gas, the gas will escape and air from without penetrate in its turn within the vessel. The injurious dilution of coal gas by atmospheric air may occur in this way in the works, or out of them in the mains, the lightest elements of the coal gas effecting their escape first and with the greatest rapidity.

Although this consideration has a theoretical value, practically it is not of frequent importance, as leakage of gas from mains, etc., is generally a process of effusion, whereby the gas pours out in an almost homogeneous mass. Marsh gas is the second member of the heating gases; its gravity is 0·557, its calorific power 13,063 units, its calorific intensity 2,630° C. It thus presents a marked contrast to its companion, although it is a non-luminous gas, excepting a few candles of light claimed for it, and assists in raising the temperature similarly as hydrogen. It is, however, its gravity which renders its presence useful in the coal gas type of gases. It gives body to the gas, a definite weight and texture. It is true we could have a gas in which the burning fluid was wholly hydrogen, and the necessary gravity supplied by increased proportions of hydrocarbons, which would likewise overcome its high heating power, but in the actual economy of coal gas manufacture, hydrocarbons are not abundant, and the marsh gas protects them from a too sudden and complete destruction in so hot a flame as we would have were hydrogen substituted for it, while it makes the gas more manageable to the engineers and more serviceable to the consumer. Marsh gas should not exceed the hydrogen, and should, in fact, be regarded rather as a preservative element than a directly useful one in the gas, where, if its presence is excessive, it raises the gravity of the gas, which in turn necessitates increased pressure, and that reduced luminosity unless compensated for by more or richer hydrocarbons. Neither is it desirable to have it sink below thirty per cent., as in the average percentage of hydrocarbons, its replacement by hydrogen would seriously affect the proper combustion of the latter, as well as inducing costly and needless expenditure of gas by the consumer.

Carbonic oxide concludes the list of heating gases. Its gravity is 0·967, its calorific power 2,400 units, and its calorific intensity 1,975° C. It is a heavy and a highly heating gas. Carbonic oxide may be considered an adventitious member of coal gas constituents, and essentially is of no service. It is rather a necessary accident of gas making than a desideratum. The engineer must endeavor to reduce its percentage as low as possible, replacing it by hydrocarbons or marsh gas. Were marsh gas absent, carbonic oxide would serve its purpose, securing by reason of its gravity just that stability for the gas which it is the office of marsh gas to supply. Further it abets the heating power of the hydrogen, and it thus enables the engineer to increase the hydrocarbons and obtain a higher candle power for his gas.

In water gas it actually plays the same role as marsh gas in coal gas, and in the former, marsh gas may be regarded as an accidental and undesirable event, just as the presence of carbonic oxide in coal gas is considered detrimental. Its poisonous properties are well understood, and on sanitary grounds its presence is obnoxious. In reality it is the only organic poison in coal gas, the other gases permitting inhalation, though of course devitalizing and injurious. In experiments made by the writer upon a gas containing small quantities of carbonic oxide, and upon a gas heavily charged with that body, the rapidity with which death ensued upon the introduction of a rat into the latter over that in the former was nearly proportional to the respective percentages of carbonic oxide in both. Carbonic oxide may help to keep up the heat of a flame where for some reason the marsh gas is excessive in a coal gas, but a large proportion indicates aberrant working. It may very frequently arise from the most mischievous of causes, viz., the admission of furnace gases into the retort with atmospheric air toward the end of a charge where high exhausts are used or where the retorts are old and cracked. The carbonic acid thus sucked in and that formed in the retort is converted to carbonic oxide among the incandescent coke. Of course any such accident causes a widespread derangement of the proportional parts of all the constituents, and destroys the balance of the gas.

Of these gases, two, hydrogen and carbonic oxide, are formed towards the middle and end of the charge at high heats, while the marsh gas is produced at the very first. In an analysis of the process of distillation previously given it was shown that the illuminants passed off first from the charge and were followed by the thinner gases. The actual result of experiments shows this as follows, the table being an average of Dr. Henry's experiments in five different gas works:

	Sp. Gravity.	Hydrogen.	Marsh Gas.	Olefines.	C rbon Monoxide.	Nitrogen.
1st hour	0·633	8·3	70·8	12·3	5·8	2·7
5th "	0·500	21·3	56·0	7·0	11·0	4·7
10th "	0·345	60·0	20·0	0·0	10·0	10·0

The same fact is also very well shown in Erdmann and Komhardt's experiments on the varying gravity of the gas during six successive hours after the change was made:

Hours after commencement.
Specific Gravity.

	1	2	3	4	5	6
Erdmann	0·6	0·52	0·43	0·37	0·27	0·3
Komhardt	0·416	0·397	0·353	0·293	0·24	

The second group of gases into which we divide coal gas is that of the hydrocarbons, those high compounds of hydrogen and carbon which impart light to the gas flame when properly burnt, viz., not over or under burnt. These gases are olefiant gas C_2H_4, propylene C_3H_6, butylene C_4H_8, acetylene C_2H_2, allylene C_3H_4, benzene vapor C_6H_6. The principle involved in their supply of light is similar to that in the process by which carbon is deposited in the retorts. At a high temperature these hydrocarbons become dissociated; they fall apart into marsh gas and vapor of carbon, and this latter forming a veil of minute points is raised to incandescence or a lower heat by the combustion of the other gases and emit light until destroyed and burnt up into carbonic acid. The necessity indicated above for a high temperature is shown here, first, because it rapidly decomposes the hydrocarbons, and from certain theoretical considerations probably produces a vapor whose carbon particles are more minute than would result from disassociation at a lower temperature; and secondly, because the intense heat as rapidly brings them into incandescence. A subsidiary benefit is also gained, since the marsh gas which results from the falling apart of the hydrocarbons, as is well known, if withdrawn from air, decomposes into hydrogen and carbon, and this may also partially take place within the gas flame. It is obvious that were a gas so highly charged with hydrocarbons that the flame became overcrowded with carbon vapor so that the heat would be insufficient to raise it to whiteness, then the light would in consequence become orange or red. The importance of this consideration, as to the high heat required in a gas flame for its best and most satisfactory appearance, is based then upon, first, the belief that the light arises from incandescent particles of carbon; second, that high heat more instantly and, so to speak, more diffusely, splits up the hydrocarbons into simpler elements. As a corollary from this last hypothesis we say the illuminating power of two flames is proportional to the number of their radiant particles at a high heat. In other words, light results from collective mass and velocity; the atoms supply one, the temperature the other.

Although the reality of this explanation of the luminosity of flames in general has been called in question, not altogether without reason, yet there seems little cause to doubt that in the case of the gas flame it is entirely just. Carbon is certainly separated, and although in a gas flame the soot deposited on a cold surface is not absolutely pure graphite, practically it is so. That collected by Stein upon a silver vessel sunk two to three millimeters in the flame of a slit burner, gave a trace of a solid yellow body when treated with benzene, while alcohol and alcoholic alkalies and diluted sulphuric acid extracted nothing. This soot when washed gave:

Carbon	96·444
Hydrogen	1·051
Ash	0·97
Oxygen	1·533

The oxygen is supposed to arise from water yet clinging to it, removing which, and disregarding the ash, we may write the composition as C 99·095, H 0·905. This body, which is virtually pure carbon, added to a hydrogen flame makes the latter luminous, and exactly similar conditions in the flame from which it was abstracted force us to conclude it was the cause of the brilliancy of the latter. In true coal gas the olefiant gas exceeds the other hydrocarbons. But heavy tar vapors exist in well purified coal gas along with the hydrocarbon gases in almost imperceptible quantities, but to an extent sufficient under some circumstances to be annoying by their settling and aggregation in meters, elbows, etc. Naphthalin, a solid hydrocarbon, may be extracted from almost any gas by passage through a glass tube under ice, stuffed with thin disks of tin perforated by a sieve of fine holes. Gas which previously may not have been suspected of containing this crystalline substance yields it upon such treatment. The writer has obtained small groups of naphthalin crystals encircling the holes made in the tin disks. The presence of solid or semi-solid bodies in gas, as a rule, is objectionable; they burn slowly, are indeed apt to flit through the flame, escaping complete ignition, and they absorb heat, while they disturb the smoothness of the flame in their sparkling transit; and in one case known to the writer, irritated weak lungs breathing the air they filled. These hydrocarbons are not supposed to be all produced in the act of distillation, or if so not to remain unchanged. For instance, Berthollet has devised a theory of mutual interaction, by which new bodies are formed and old ones replaced or dismembered at high heats within the retort chamber. Thus this author found in the Paris gas: Benzene (in vapor), acetylene, ethylene, propylene, allylene, butylene, crotonylene, terene, and their polymeres, all of which he regards as formed from the four fundamental hydrocarbons, acetylene, ethylene, dimethyl, and methane, along with hydrogen.

The third group is composed of nitrogen, a heavy, inert gas making up four-fifths of the atmosphere, and due to admixture of air when found in large quantities. This gas should not exceed three per cent. in the gas, and even at that it is incontestably due to air. It is true that coals will yield nitrogen, but this is limited to a small quantity only; and it has been, with some reason, questioned whether any nitrogen can be evolved from the distillation of the coal, except what has been entrapped as air in the interstices of the charge and pores of the coal. The nitrogen increases its gravity without bestowing any compensating advantage on the gas, and in addition adds its own useless volume to be heated up to the point of combustion of the other combustible gases. It does not burn, but absorbs and wastes the power of the flame by reason of its high specific heat.

The fourth group embraces oxygen, carbonic acid, sulphur, and ammonia. Oxygen enters the gas in the air, which effects admixture with it and is regarded as a sure indicator of the latter. The oxygen of the original volume of air which was introduced in the gas is destroyed by union with carbon, appearing in the gas as carbonic acid and carbonic oxide. The immense detriment, generally speaking, exercised by the oxygen upon the gas, will be alluded to further on in relation to the principle it involves. The actual loss of light effected by the presence of air in gas is by no means a settled matter. Messrs. Andouin and Bérard, in examining the question, reported "rather more than six per cent. loss for each one per cent. of air added to the gas, reaching a total loss of 80 per cent., with 15 per cent. added." Mr. Carl Schultz concludes from his experiments that when "coal gas is mixed with atmospheric air its illuminating power for all five foot burners is reduced in the proportion of half a standard candle to every 1 per cent. of air present," and "that, this loss being constant, the percentage of aggregate loss will vary with the illuminating power of the gas used."

Silliman and Wurtz examined this question, using the gas

* Concluded from SUPPLEMENT, No. 199.

of the Manhattan Co., of New York, in 1869, and the following schedule shows their results:

Vol. of Air Added.	Candle Power Before Addition.	Candle Power After Addition.	Loss of Candle Power.	Percentage Loss of Candle Power.
1·05	15·12	14·20	0·92	6·08
1·82	14·67	13·27	1·40	9·54
2·25	14·71	12·96	1·75	11·82
3	14·81	12·49	2·32	15·69
4·95	14·81	11·28	3·53	23·83
11·71	14.81	8·67	6·14	41·46
16·18	14·81	6·29	8·52	57·53
20·76	15·09	4·09	11	72·9
24·68	14·11	2·18	11·93	84·55

These experiments show that in the case in hand, "for any quantity of air less than 5 per cent. mixed with gas, the loss in candle power due to the addition of each 1 per cent. is a little over $\frac{4}{10}$ of a candle; above that quantity the ratio of loss falls to ⅓ a candle power for each additional 1 per cent. up to about 12 per cent. of air; above which up to 25 per cent., the loss in illuminating power is nearly $\frac{4}{10}$ of a candle for each 1 per cent. of air added to the gas." It is, at any rate, certain that the admixture of air in a gas will produce varying results according as the luminiferous richness of the gas itself varies, and that the poorer, thinner gases will always suffer the most from such deterioration. Carbonic acid being itself the product of combustion cannot, of course, assist the flame, and only withdraws heat; but in addition, in rich gases, it undergoes decomposition into two volumes of carbonic oxide by reaction upon the incandescent carbon points, and any considerable quantity will seriously affect the illuminating power of the hydrocarbons in this way. The current statements as to the effect of carbonic acid upon the illuminating power of the gas are as much in need of correction and modification as those in respect to air, for in respect to both their effects change with the character and constitution of the gas affected. Sulphur in purified gas is usually there in the form of bisulphide of carbon, sulphureted hydrogen, sulphide of ammonium, a sulphocyanide, and hydrocarbon sulphurets. It has long proved a *bête noire* to English gas engineers, and we have already shown the discussions and discoveries its presence lead to there. The American coals are less contaminated with sulphur, and with proper lime purification there should be no difficulty in conforming to the standard of a maximum of 20 grs. S in 100 cubic feet gas. In the flame, especially in poor gases burning under a high pressure, it is burnt into sulphurous and sulphuric anhydrides, which driven into the air of a room vitiate it, and corrode and destroy metallic objects and delicate tapestries. Many writers and engineers deride the alarm felt about the presence of sulphur in gas, and ridicule the institution of any fixed standard. There has, no doubt, been gross exaggeration of the evil effects of sulphur in street gas, but when a gas gives a reaction on test paper for sulphureted hydrogen there can be no question as to its insanitary character, and gases in which are found from 30 to 40 grs. of sulphur in 100 cubic feet, usually contain that poisonous body. Ammonia in gas is considered objectionable because it may form in combustion acid compounds of nitrogen, though in gases filled with sulphur it in part neutralizes the sulphur acids. It is not a very hurtful ingredient in the gas, but is a useless body; is more desirable in the gas liquor than in the gas flame, and sometimes is an index of abnormal working, insufficient washing, or poor coals.

THE GAS FLAME.

A gas jet burns, because under the initiatory stimulus of heat the chemical affinities between the oxygen of the air about and the constituents of the gas are so vigorously excited as to cause their union, and thereby an instantaneous evolution of heat and light. The products of complete combustion are water (H_2O) and carbonic acid (CO_2), and the oxygen in these products comes from the surrounding atmosphere; therefore in the first place a supply of air ample enough to provide the hydrogen of the gas with enough oxygen to form water, and to the carbon enough oxygen to form carbonic acid, is indispensable. And in the second place, the gas itself must be composed of bodies rapidly and easily ignited. And lastly, the disposition and structure of the gas jet must be such as to facilitate and utilize its own combustion. Any ordinarily well ventilated room answers the first requisite. The air of a room should be free from draughts, inasmuch as they impinge on the flame, momentarily cool it, and cause a discharge of smoke and unburnt carbon. In cool rooms gas flames are apt to burn more brilliantly than in very hot ones; the passage of the air to and upward with the flame is more rapid and uniform. The second consideration is the composition of the gas itself, and as we have seen the constitution of coal gas is one admirably calculated to secure the legitimate ends of its manufacture, viz., light. The hydrogen at a comparatively low temperature unites with the oxygen of the air, streaming inward for its supply, and starts the flame; the carbonic oxide at a higher temperature ignites next, and then the marsh gas follows, the three in burning forming the blue zone in the flame where no light is emitted, but the necessary heat evolved for the decomposition of the hydrocarbons and the incandescence of the carbon points higher up in the luminous band of light. Professor Landolt examined critically the process of combustion in a flame of Heidelberg coal gas, and the instructive table taken from his memoir, with Professor Thorpe's commentary, is quoted here:

COMPOSITION OF COAL GAS FLAME.

Height from Burner in Inches.	0	0·39	0·79	1·18	1·58	1·97
Hydrogen	22·66	14·95	5·49	15·54	14·50	11·95
Marsh gas	33·77	30·20	28·34	21·55	11·92	3·64
Carbonic oxide	7·34	14·07	14·05	14·58	22·24	25·14
Olefines	7·29	7·49	7·87	7·94	7·05	5·45
Oxygen	0·66	0·78	0·47	......	......	......
Nitrogen	29·41	38·66	140·78	184·33	270·45	307·10
Carbonic acid	1·94	2·34	10·11	14·98	23·76	32·34
Water	8·34	11·60	38·85	52·55	72·07	75·61

"At a height of 1·18 inches a sudden break in the continuity of the rate of decrease of the hydrogen is observed, due either to the reducing action of carbon on the water vapor or to the dissociation of that vapor at the high temperature. The marsh gas only slowly diminishes up to this point, after which its rate of diminution is very rapid, whilst the olefines burn only in the upper part of the flame. The great increase in the amount of carbon monoxide at 1½ inches, is probably due to the action of the strongly heated carbon on the carbon dioxide."

The arrangement of the burner should be such, varying of course according to the nature of the gas and the conditions under which it burns, as to allow enough air to mix with the gas so as to burn the hydrocarbons to the best advantage. If a rich gas, more air must combine with the flow of the gas in order to consume the heavy carbon illuminants, than if a poor gas, in which if too much air enters, the excessive heat and the energy of combustion will destroy the illuminants and its photometric power be lowered. A gas may therefore be over or under burnt, and the manifold devices, whose number may be more easily suggested than counted in the making of burners, are simply efforts to secure to a great many kinds of gases, used at different pressures and in different quantities, their appropriate supply of air. In flat burners, whether bat's wings or fish tails, the pressure under which the gas issues from the tip and the thickness or thinness of the gas sheet control this matter. The gas rushing from the burner under a high pressure pulls the air into the upward current, and a strong, rapid combustion ensues, which narrows the luminous zone and produces a hot and short flame, and similarly a narrow fan of flame exposes an increased surface of gas to the contact of the atmospheric oxygen, and also results in a vigorous combustion. A thin gas ranging from 0·45 to 0·52 should burn under scarcely any pressure, the intermixture with air being determined by the lowest chemical activity necessary to keep it alight. Gases rich in hydrocarbons and of a gravity ranging from 0·54 to 0·7, actually need a plentiful supply of air to assist their burning, and Mr. Schultz instances a case of an especially rich gas which was benefited by the introduction of as much as 12 per cent. of air into the gas itself before use. Strong pressures are getting more in vogue with the spread of heavy naphtha gases, whose luminiferous constituents demand a generous supply of air as well as from the mechanical necessity of forcing a sufficient amount of gas through the burners. Mr. Stewart's experiments on the influence of pressure upon an ordinary cannel coal gas are in this connection interesting. The consumption was kept constant, as of course a serious loss of light under high pressure is compensated, at least in part, by increased consumption of gas.

Pressure.	Burner.	2 Cubic Feet Gas Used, Candle Power.	5 Cubic Feet Gas Used, Candle Power.
2 in.	No. 0	3·55	8·9
1·3 "	" 1	7·6	19
0·66 "	" 2	11·0	27·5
0·45 "	" 3	12·5	31·25

As a rule, Argand burners or cylindrical flames with a core of air admit of most satisfactory adjustment to the necessities of a gas, the size of the holes in the crown and the diameter of the air current being variable quantities, which can for any particular and uniform gas be arranged to a nicety.

The best light is a white light, and this is obtained only at high temperatures with an adequate supply of hydrocarbons, the latter not lower than 5 per cent. A series of chromatic tints corresponding to increasing temperatures may be observed in the flame. Deville found that a light passed from red to yellow, which latter color as it predominated, with the residual red formed orange; a blue tint then appeared, which, with the still existing red and yellow lights formed white, an index of the highest temperatures.

Gas deteriorates upon standing in contact with oil in close vessels, mains, etc., or over water. Dr. Ure found that oil gas of a gravity of 1·054 giving 1 candle upon the consumption of 200 cubic inches, after being kept for 3 weeks required 600 cubic inches to give the same light; and also coal gas giving the light of 1 candle with a consumption of 400 cubic inches in 4 days, will require a consumption of 460 cubic inches to produce the same light.

Aiken's, of Baltimore, experiments are summarized in the following table:

Gas from main	Candle power	10·71
" standing 24 hours	" "	3·50
" " 2 days	" "	3·20
" " 3 "	" "	1·90
" " 4 "	" "	1·75

The change in gas after standing resulting in lower illuminating power is proximately due to an alteration in the character of the hydrocarbons, accompanied by slight deposition of partially vaporized oils, and tarry substances, and the introduction of air. The varying degrees thus attained in different gases is determined by the fixity and more or less complex nature of the hydrocarbons.

SYNTHESIS OF FORMIC ACID.

V. MERZ and J. TIBIRIÇA sum up the results of an elaborate investigation on the action of carbon monoxide on alkalies with these statements:

Carbon monoxide is absorbed by caustic alkalies at about 200°, and a salt of formic acid is produced.

In order to saturate caustic soda as thoroughly as possible, it should be used in the form of soda-lime; this should be very porous, the gas should be moist, and the temperature not above 220°.

As the absorption of carbon monoxide takes place rapidly when the proper precautions are observed, formic acid or formates may best be prepared on the large scale from inorganic material.

According to the information furnished in Wagner's "Jahresbericht," formic acid appears to be used principally in the manufacture of certain esters. But it would now be interesting to determine how far this acid may be used for technical purposes in place of acetic acid, and also as a reducing agent. It should further be remarked that, according to Jodin,* free formic acid is an antiseptic, and under some conditions is superior to phenol in this respect. —*Ber. d. deutsch. Chem. Gesell.*

ARTIFICIAL ALKALOIDS.

A. LADENBURG continues his interesting studies of the alkaloids. He finds that the atropine obtained by him in treating the tropate of tropine with dilute hydrochloric acid is identical with natural atropine. He has, further, treated other salts of tropine in the same way, and thus obtained representatives of a class of artificial alkaloids to which he gives the generic name *tropeïnes*. The three substances of this class described are made from the salicylate, oxytoluate, and phthalate of tropine. Oxytolutropeine acts upon the human pupil almost as energetically as atropine. It has been used extensively in the ophthalmological clinic, and the conclusion drawn from the experiments thus far performed is that in many cases it is to be preferred to atropine.—*Ber. d. deutsch. Chem. Gesell.*

* Wagner, "Jahresbericht," 1866, 287, and "Zeitschrift f. Chem." 1866, 95.

BLEACHING TEXTILES OF ANIMAL OR VEGETABLE ORIGIN.

M. CLEMENT proposes the following method: He remarks that in every bleaching process the first step is to free the goods from all dressing, etc., which has been applied by the weaver. At present for this purpose the cloth is steeped in lukewarm water and in alkaline lyes. On the new system this part of the process is effected in the cold. The cloth is put to steep in water with the addition of yeast, and all sizes and dressings are removed by fermentation without any action upon the fiber.

In twelve hours the fermentation is over; the goods are well rinsed and passed into an oxidizing bath composed as follows:

Water	200 galls.
New oxidizing salt	1 lb. 1½ oz.

[We pause here to make a remark: The process before us is a patent. Now one of the first conditions of a patent is that every article directed to be used for any purpose must be fully and plainly described, so that, after the expiry of the patent, any person who wishes to use the process may either know how to make the articles required himself, or to buy them in open market. If an inventor does not thus fully describe how his invention is to be performed he violates this condition, and in England, at least, protection will be refused him. The process before us, so long as the composition of this "new oxidizing salt" is not stated, is a mule between a patent and a trade secret, and as they say in Mexico, "there is no sense of honor in a mule."]

The proportions of the oxidizing bath cannot be given exactly, for it differs according to the degree of bleaching and the rapidity of action desired.

After steeping for an hour, rinse strongly and plunge into bath No. 2.

Water	200 galls.
Sulphite or hyposulphite of soda	3 lb. 4½ oz.
Sulphuric acid	1 lb. 10 oz.
Carbonate of soda	8¾ oz.

[Here we are again forced to make a remark: The strength of the sulphuric acid is not given. If we suppose it to be full strength—what is commonly called D. O. V.—we are still left in doubt whether the carbonate of soda is soda-crystal, or soda-ash of a low or a high strength. At all events the carbonate of soda will merely serve to neutralize a part, more or less, of the sulphuric acid.]

After soaking for two hours, rinse and place in a bath of hypochlorite of soda composed as follows:

Water	200 galls.
Hypochlorite of soda [what strength?]	66 galls.
Carbonate of soda	5 lb. 7¼ oz.

After soaking for eight or ten hours, the bleaching is generally complete for cotton. It is merely requisite to rinse, pass again into the second bath for an hour, rinse again, and finish in the ordinary manner. For calico these various operations are repeated in the same order till the result is satisfactory. Three operations generally suffice. The bleaching of wool differs from that of cotton by a first preparation used in place of yeast. The following method for bleaching raw wool may serve as an example.

It is customary to ungrease wool either with the grease of a former lot, an old bath, or with stale urine.

The new system differs here essentially from the old, as it begins by oiling the raw wool with oleic acid, or an emulsive oil. When this has been done the wool is allowed to lie for a couple of hours or more, and is then washed with pure water cold, or at a band heat, until it is no longer colored.

The soaking in water presents no inconvenience for the fiber; the wool, being saturated with oil, can neither swell nor break, and felting is rendered impossible.

All the earthy parts and other impurities which soil the wool are removed by this first washing (?) The wool, after draining, is washed anew in a bath composed as follows:

Water	200 galls.
Prepared liquid	3 galls.

This prepared liquid consists of a mixture of 66 parts by measure of liquid ammonia, and 33 of mineral essence (evidently one of the light petroleum products).

This mixture is well stirred up together before being poured into the beck. The whole must be well stirred before entering the wool, which is then washed as usual. The wool is thus perfectly free from grease in a few minutes, and of a degree of whiteness which has not hitherto been attainable, and is, besides, very supple. The white may be still further improved by treating the wool as for cotton, leaving out the hypochlorite bath.—*Teinturier Pratique.—Chemical Review.*

BLOOD ALBUMEN.

THE blood of the slaughtered beasts is caught and allowed to coagulate in trays, so that the albuminoid liquid (serum) may be carefully run off from the clot. For this purpose the trays are collected in a cool place, so that the separation may proceed more easily. In warm weather, or in warm climates, artificial cold may be usefully applied as generated by a freezing machine such as that of Pictet & Co. The clot which is formed is thrown upon a linen filter, and gently pressed, in order to secure any albumen which has been retained. The residue is then cut in pieces and dried upon zinc plates in a drying chamber. The albumen is poured in very thin layers upon zinc plates turned up at the edges, and dried at temperatures not exceeding 88° to 95° Fahr. The zinc plates are previously rubbed over with a little olive oil, in order that the dried albumen may not adhere to the metal. In order to free this albumen as far as possible from all other substances which might adhere to it, it is covered with distilled water, which is allowed to stand for a time and then run off. The easily soluble phosphates are thus removed. The residue is then drenched with warm distilled water, with occasional stirring, whereby the blood albumen is gradually dissolved. The solution is then strained through flannel, when the impurities and the coloring matter remain behind. The filtered, concentrated solution is again placed on the zinc trays, and dried down as before at 88° to 95° Fahr. E. Campe, of Brünn, has made known some important observations concerning the details of this process. In order to obtain the albumen as free as possible from color, very great care must be taken in collecting the blood. An essential condition is that the locality where the collecting trays and strainers are placed should be as near as possible to the slaughterhouse. The serum should be drawn off either in or close to the slaughterhouse, and the blood should be thrown on the sieves or strainers within half an

hour or an hour of the time when it was caught. The clot is cut up into lumps about an inch square, thrown on the sieves, and the serum is allowed to drop from forty to forty-eight hours. After the expiry of this time the serum is drawn clean off from the dishes, taking care that the red coloring matter of the blood does not run off along with the serum. The arrangement for this purpose is very simple; the dishes are rather concave at bottom, thus forming a kind of well, where this colored liquid may collect. In the bottom a ring is soldered, standing up about one-eighth of an inch above the bottom, and receiving a cork. The cork is perforated, and through it passes a tube which slides up and down. When the serum in the dish appears clear this tube is pushed down till its upper end is just below the surface, and the serum is thus allowed to flow off. By thus gradually and carefully lowering the tube the whole of the clear colorless portion may be drawn off without disturbing the coloring matter.

After all the dishes have thus been emptied, all the serum is poured into tubs of soft wood capable of holding three to four hundredweight. These tubs are wider at top than at bottom, and are fitted with spigots at two to three inches from the bottom. In the subsequent treatment of the serum it now depends whether the object is to prepare natural albumen, without gloss, or the glossy so-called patent albumen.

For the former there is taken per cwt. of serum ¼ lb. oil of turpentine, which is well stirred in for an hour. For this purpose Campe uses a circular board, about a foot in diameter, perforated with numerous holes and fixed at the end of a handle. He then allows the serum to stand covered from twenty-four to thirty-six hours. The turpentine then separates on the surface, mixed with a smeary greenish-white fat. The clear serum is then run off through the spigot fixed at two inches from the bottom. The first quart which passes through is caught separately, as it is always turbid; the rest of the serum is taken to the drying-room as soon as it is drawn off. For this purpose Campe uses moulded enameled iron dishes, twelve inches long, six broad, and three-quarters deep.

The temperature of the drying-room when the dishes are being filled should be 122°; when the dishes are full it is quickly raised to 126°—131° Fahr., and this temperature is maintained for two hours without opening the ventilators. After this time the valves are opened and the temperature allowed to fall to 117°—120° Fahr., which is maintained to the end of the operation. The valves are opened here and there in order to introduce dry air in place of moist. To obtain a quick circulation of air, Campe constructs openings in the floor; the exit holes are, of course, in the roof.

To prepare the so-called patent albumen with a fine luster, Campe takes per cwt. serum 6⅔ drms. of oil of vitriol and 12¼ oz. of concentrated acetic acid at 1·040; mixes them together, and after the mixture has stood for an hour, dilutes with 6 lb. of water, and pours it into the serum in a very slender stream, stirring all the time; ¼ lb. oil of turpentine is then added per cwt. of serum, and the whole diligently crutched for sixty to ninety minutes. It is then allowed to stand covered for twenty-four to thirty-six hours as before, and drawn off in the same manner as already described. Before placing in the drying chamber it is mixed with ammonia till it shows a faintly alkaline reaction, in order to remove every trace of free acid. The dishes are rubbed over with warm ox tallow, to prevent the dried albumen from adhering.

By this treatment a portion of the albumen of the blood is secured as so-called first quality blood albumen. It is never quite equal to egg albumen, but when carefully prepared it may serve for printing bright shades, with the exception of such as are very light.

The second quality, which can only be used for printing dark or very heavy shades, may be called an accidental product, as it is made from the contents of those dishes into which by any mishap more or less of the red coloring matter has entered. Campe uses for this quality also the reddish liquids remaining after the first quality serum has been drawn off.

The third quality is used by sugar refiners, and is obtained from the lumps of clot lying upon the sieves and from any darker residues obtained in any part of the process.—*Chemical Review.*

ABSENCE OF MIND AS A SIGN OF INCIPIENT MENTAL DISEASE.

AMONG the diseases of modern life it is generally acknowledged that the forms of insanity hold a prominent and increasing frequency. The fact has indeed been discussed and doubted. It has been said that it is their recognition, rather than their actual increase, which has led to this statement. But the most recent investigators incline to the opinion that the growth of mental disease is real, and not apparent only; that it rests upon certain unhealthy conditions of modern society; and that probably it is destined to be yet more positive in the future.

If such is the case, the propriety of the study of mental hygiene will force itself more and more on the profession and the public. Little has been done, so far, in this direction. One class of writers maintain that the prime condition, and almost the only one, required to secure a healthy mind is to have a healthy body; unmindful of the fact that there are scores of lunatics in every large asylum who, so far as their apparent physical condition is concerned, would be received as first class risks by any insurance company in the land.

The true principles for the preservation of mental health must be drawn from an attentive study of the physiology of the mind, as well as its pathology. The workings of the mind in health give many hints as to the tendencies which, if allowed to gain the upper hand, lead it insensibly to disease. Perhaps no one trait illustrates this better than the common one of "absence of mind," as it is termed, meaning by this generally that form of waking action which is carried on unconsciously.

Closely allied to it, indeed, merely a form of it, is the process of "unconscious cerebration," which of late years has occupied so much the attention of physiologists. They have demonstrated that often the greater part of our actions are carried out by voluntary effort wholly independent of consciousness. We walk, write, eat, and do a thousand common things, without being in the least aware of the different efforts which we require to perform them. Were we to direct our attention to each of these efforts singly, we should accomplish very little, and the fatigue would be immensely greater. It is habit that facilitates our labors to such an amazing degree.

While it is essential to skill that the muscles must thus work unconsciously, the moment they assert, as it were, their independence of self-consciousness, and prompt to the initiation of efforts outside of what they have been taught, a pathological condition is begun, which we call "absence of mind." Such a habit begins in little things, more generally by an omission than a commission. Thinking of something else while dressing, a part of the toilet is overlooked, the necktie is forgotten, the wrong coat is put on, the hair is unkempt.

Soon, as the habit increases, absurd and even harmful acts are committed. The collections of anecdotes are full of stories of such follies. We knew an able young lawyer who, instead of pouring a tonic from a bottle on his desk, carefully emptied the ink from his inkstand into a spoon and swallowed it! Another, an ex-Attorney General of the United States, went on a fortnight trip to attend an absorbing legal case. His wife packed a half dozen shirts in his portmanteau. On his return there were no shirts visible. Pushing her inquiries, she found that her husband had regularly donned a clean shirt every other day, as was his wont, but had forgotten to take off the soiled one, and now returned wearing the whole half dozen!

An authentic anecdote of the great political economist, Adam Smith, tells us that when called upon to sign a contract, instead of writing his own name he made an elaborate imitation of the signature of the other party, which had already been affixed.

Such incidents tend to depreciate a man, though perhaps unjustly, in the opinion of those with whom he does business. They become, also, a grave annoyance to the individual himself. In a sense, they are mental weaknesses which, pushed to a certain degree, pass into mental diseases. Senility and insanity are not unfrequently marked by automatic actions, carried out without the will or consciousness of the doer. The absent-minded one, like the sleep-walker, performs actions without knowledge of them, and neglects duties which are pressing. Justly, therefore, it is a source of anxiety with every thoughtful person when he finds himself falling into this bad mental habit.

It is usually gradual in its onset, stealing over one in moments of intense occupation. Unlike many other mind weaknesses, it is not the foe of the idle man so much as the busy one. Yet habits of reverie and day dreaming may also bring it about. Wrapped in the enchanting vocation of castle building, one may forget that his house should stand first in his thoughts.

Those who feel this habit creeping over them will do well to make an early and special effort to resist it. It can be conquered by a habit of attention, and by a severe self-chiding when the mind yields to it. Ruskin, who has said many wise things about self culture, recommends the absent minded man to take a sea voyage, not as a passenger, but as a sailor, and then his very life will depend on his constant attention to his surroundings. To quote his own beautiful expression:

"Ocean-work is wholly adverse to any morbid condition of sentiment. Reverie, above all things, is forbidden by Scylla and Charybdis. By the dogs and the depths, no dreaming! The first thing required of us is presence of mind. Neither love, nor poetry, nor piety, must ever so take up our thoughts as to make us slow or unready. In sweet Val d'Arno it is permissible enough to dream among the orange blossoms and forget the day in twilight of ilex. But along the avenue of the waves there can be no careless walking."—*Med. and Surg. Reporter.*

RIDER'S SPRAIN.

IN speaking of sprains, M. Delorme states, in *Nouveau Dictionnaire de Médecine et de Chirurgie Pratiques*, that he has seen a large number of a form to which he applies the term "entorse des cavaliers," or rider's sprain, which is common among troopers. It arises from the fact that, at the moment of falling, the foot is slightly extended, and touches the ground first with the toes, then with its whole external border. The weight of the animal now bears on its internal border or, more rarely, on the toes alone. Lastly, the stirrup, which habitually occupies an oblique position, directly twists the fore part of the foot upon the after part. The pressure on the external border of the foot, caused by the rotation of the toes from without inward, and of the forced adduction, is exerted on the metatarso-phalangeal articulation, upon the external tarso-metatarsal articulations, upon those of the astragalus, and secondarily upon the external ligaments of the tibio-tarsal joint. Sprains of this kind are of the most serious nature, and disable a man for a longer period than many fractures.—*Med. and Surg. Reporter.*

ADMINISTERING MEDICINES.

WE clip the following from the *American Poultry Yard:*

All medicines are most easily given to animals in solution, but pills and other solids *will be swallowed, if thrust far enough back in the mouth.* In doing this, remember the natural position of the hen's head in drinking, and keep the bill of the fowl upward and the neck stretched. This can be done by one person conveniently, if the left arm or elbow hold the fowl in the lap, while the bill is opened with the left hand. Give the dose slowly, in small quantities.

The cheapest way to get the medicines is to buy them in bulk. Then if you have not scales of your own which will weigh small quantities, get your druggist to weigh out a single grain, and keep this as a measure:

TABLE OF APOTHECARIES' WEIGHTS.

20 grains make one scruple.
3 scruples make one drachm.
8 drachms make one ounce.
12 ounces make one pound.

TABLE OF APOTHECARIES' FLUID MEASURE.

60 minims make one drachm.
8 drachms make one ounce.
16 ounces make one pint.

For rough measuring of fluids, it is considered that a teaspoon holds one fluid drachm; a tablespoon half a fluid ounce; and a wine glass two fluid ounces. A drop is larger with some fluids than with others; water has about sixty drops to a teaspoonful or fluid drachm; laudanum (and all tinctures and alcohol) has 120 drops to a fluid drachm. But no such rough-and-ready method of measuring should be applied to such dangerous drugs as tartar emetic, strychnine, aconite, and colchicum. These and laudanum are poisons, and should also be kept out of the way. Other drugs, which in some of their uses have proved dangerous to fowls, and therefore need to be carefully handled, are sulphur, kerosene, carbolic acid, and mercurial ointment.

Fowls need large doses for such small animals. When you do not know how much of a medicine to give, ask your druggist how much is a dose for a child. Give a chicken a fortnight old as much in a day as would be given to a child six months old. A bird six weeks old needs as large a dose as a child of a year old, and a half-grown fowl as much as a two-year-old child; while an adult bird's dose is such as is proper for a child three or four years old.

TONICS AND STOMACHICS.

The best tonic is iron, a few drops of the tincture being mixed with the drinking water, or half a dozen rusty nails being thrown to the bottom of the drinking vessel. This is especially advisable during moulting.

Cayenne pepper and assafœtida are good digestive stimulants. So, also, is gentian. Ale is a good general stimulant. In using cayenne pepper, be careful to buy a good article, and do not use too much of it at once, so as to disgust the fowls, nor continue the use of it long. Assafœtida, garlic, and onions all have a good effect on the lungs and bronchia. Ginger will weaken the digestive organs if used too long.

Charcoal (and you can economically use the little bits of charred wood that remain after every wood fire) is a good purifier of the digestive organs, as it absorbs fetid matters; it stimulates digestion also. Furnish it in small pieces about the size of grains of corn; they will swallow it when they need it, particularly if some in a powdered state has been previously added to their soft food to teach them.

Sulphur is a very valuable drug to the poulterer, but should be used carefully in the case of young chicks, as many have been reported killed by its use externally, and apparently more often when it is mixed with lard. The fine powder has also caused blindness by getting into the chicks' eyes. The flowers of sulphur are often contaminated with the oil of vitriol; to get this out, wash your sulphur carefully in hot water, which does not dissolve the sulphur. To apply it to small chickens, sprinkle it from a dredging box, and keep the chickens out of the wet for the next day. Persian insect powder is safer, however.

Lime Water.—Four ounces of lime; water, one gallon; slake the lime with a little of the water and pour on the rest. Cover and set aside for three hours; then pour off the clear liquid from the top and use the lime that is left when wanted.

Douglass' Mixture.—Copperas, one pound; dissolve in two gallons of water; then add, stirring well, an ounce of oil of vitriol; keep in jugs. This is a good tonic, in the dose of an ounce to a gallon of drinking water, twice or four times the week.

Chicken Powders (another tonic).—Four ounces each of copperas, cayenne, sulphur, and resin; powder all; mix; two spoonfuls for each dozen fowls several times weekly.

Another powder, said to be useful to turkeys before and during the "shooting the red," is powder of cassia bark, three parts; ginger, ten parts; gentian, one part; anise, one part; carbonate of iron, five parts; mix well, and give for every twenty young turkeys a teaspoonful twice a day, in the food. Begin two weeks before the appearance of the red, and continue several weeks after.

Those wishing to administer homeopathic remedies can be supplied by some good pharmacy with all the pilules needed. Keep in mind in this form of treatment, also, the comparison already made between children and fowls, in determining the doses to be administered.

CHAMELEONS.

By PROFESSOR J. REAY GREENE, B.A., M.D., F.L.S., F.Z.S., etc.

IN the system of nature Chameleons unquestionably occupy a more conspicuous place than any other family of reptiles now living upon our globe. This family constitutes one of the three sub-orders under which most herpetologists, following Stannius, arrange existing Lizards. On no family of Crocodilians, Tortoises, or Snakes can a like dignity be imposed.* The structure of the Chameleons is, in many respects, very remarkable; their habits, especially those of the common species, are yet more striking. Not even the sloths are so entirely adapted to lead a purely arboreal life. Slower in movement than the tortoises, the common Chameleon is nevertheless gifted with apparatus for the pursuit and capture of winged prey, which it finally seizes with the most unerring rapidity. Throughout the whole animal kingdom no more notable adaptation of means to end can be said to exist. Such means are at once active and passive; they are numerous and diverse. The long extensile curiously-constructed tongue, the exceptionally mobile eyes with their manifold adjustments, the changing skin, the slender limbs, specially modified for climbing, and the prehensile tail, terminating a carcass unparalleled for meagerness, are not the only parts of the Chameleon which demand attention.

It is true that a rank equal to that usually conferred on the Chameleons might be awarded the singular Hatteria (*Sphenodon* or *Rhynchocephalus*) of New Zealand, whose characters have been so well described by Dr. Gunther.† It, too, recedes from the typical lizards, while it approaches the Crocodilians and other reptiles. Its nearest affinities are less with recent saurians than with certain long extinct members of its order. In so far as it is an aberrant, it is also, for the most part, a generalized lizard, resembling lower rather than higher forms. The Hatteria deceives us, for its outward aspect gives little clew to the solution of the riddle propounded by its deeper anatomical peculiarities. For this reason it was at first erroneously classed with the Iguanas, to some of which in habit it sufficiently approximates. But the ways of the Chameleons, no less than those morphological features which yield so much delight to the pure anatomist, are at once seen to be very exceptional and worthy of note by the ordinary observer. Thus, whether we consider their structure or their mode of life, these reptiles may fairly claim the isolated position commonly assigned them.

Does the sub-order and family of Chameleons include more than one genus? The late Dr. John Edward Gray, who, during his later years, would seem to have felt a passion for the subdivision of old genera and the institution of new ones, has endeavored to establish no less than fourteen genera in place of the one usually admitted. It is difficult,

* On such questions, as to the systematic value of certain groups of reptiles, there is more or less divergence of opinion. Thus Agassiz would have separated the turtles, as a sub-order, from the remaining tortoises, whilst some have suggested a like separation of the family of geckos from other lizards. But these views have not been generally accepted. Again, the typhlopine serpents differ much in the structure of their skull not only from other serpents but from reptiles in general. Yet in the judgment of Johann Müller, who is here followed by most modern anatomists, these remarkable snakes do not constitute a group of higher rank than that of a family (Typhlopidæ). Among tortoises and batrachians, also, very notable differences as to cranial structure may exist without being accompanied by corresponding diversities, at all comparable in extent or apparent importance, in other parts of their organization. Extinct reptiles, such as Ichthyosaurus, are excluded from this comparison.

† See his memoir in the "Philosophical Transactions" for 1867.

if not impossible, to agree with this author's estimates. His thirteen new genera rest on characters which are either paltry in themselves, and perhaps not always of even specific importance, or taken from one sex only. Rightly to classify Chameleons, we need very extensive suites of specimens preserved in fluid, collected from as many localities as possible, and accompanied by the notes and drawings of intelligent travelers.

A much more competent authority, Dr. Günther, distinguished among living zoologists for his knowledge of the species and genera of cold-blooded vertebrates, has lately proposed a new genus of Chameleons, which we have no choice but to admit for the present. This genus, *Rhampholeon*, contains one well-marked species (*R. spectrum*), whose strange characters are manifest at a glance (see Figs. 1, 2). It is a small species, with an exceptionally short tail. The male has a total length of thirty-nine lines, the tail being thirteen; the female is thirty-five lines, with a tail nine lines in length.

"The tail is so short that it can serve as a prehensile organ in a very subordinate manner only. This defect is compensated by the development of an additional sharp denticle at the inner base of each claw, and of a spine vertically projecting from the flexor side of each finger and toe, which must immensely strengthen the power of the animal for holding on to branches."*

Dr. Gray's list,† published in 1864, enumerates thirty species of Chameleons (or an average of two species to each

CHAMELEONS.

of his genera). More than a dozen others have since been added.

It is very necessary to note, in our study of the variations to which the species of Chameleons are subject, the secondary sexual characters which they display more strikingly than any other reptiles. Mr. Darwin,‡ in his account of selection in relation to sex, thus treats this division of his subject:

"In the genus Chameleon we come to the climax of differences between the sexes. The upper part of the skull of the male *C. bifurcus*, an inhabitant of Madagascar, is produced into two great, solid, bony projections, covered with scales like the rest of the head; and of this wonderful modification of structure the female exhibits only a rudiment. Again, in *Chamæleon Owenii*, from the West Coast of Africa, the male bears on his snout and forehead three curious horns, of which the female has not a trace (see Figs. 6, 7). These horns consist of an excrescence of bone covered with a smooth sheath, forming part of the general integuments of the body, so that they are identical in structure with those of a bull, goat, or other sheath-horned ruminant. Although the three horns differ so much in appearance from the two great prolongations of the skull in *C. bifurcus*, we can hardly doubt that they serve the same general purpose in the economy of these two animals. The first conjecture which will occur to every one is that they are used by the males for fighting together; but Dr. Günther, to whom I am indebted for the foregoing details, does not believe that such peaceable creatures would ever become pugnacious. Hence we are driven to infer that these almost monstrous deviations of structure serve as masculine ornaments."

Here we may refer to Ford's beautiful figure* of *C. Melleri*. The snout of *C. gallus*, a small Madagascar species (Fig. 3), "has a long pointed, flexible appendage, which is covered with large soft tubercles." In both these species the male only is known, as in the no less curious *C. malthe*, *C. brevicornis*, and *C. globifer*.†

Doubts as to the limits due to variation must check our statements touching the geographical distribution of the Chameleons. We have not, hitherto, been able to reject many of the reputed species. Of others the precise range remains to be ascertained. Many seem local (confined to restricted areas).

We know no good species which does not inhabit Mr. Sclater's Ethiopian region.‡ The common Chameleon is found in Southern Africa, and is, moreover, the only well-ascertained ultra-Ethiopian species. The number of continental is about equal to that of insular species. But few species cross the equator, though the number of such species will probably be increased by the researches of future collectors. Certain it is that south of the equator Chameleons are more numerous.

Southern (extra-tropical) Africa has six species, besides *C. vulgaris*. Four are peculiar, *C. ventralis* and *C. pumilus* from the Cape, *C. namaquensis* from Little Namaqualand, and *C. melanocephalus* from Port Natal. Two others, which occur at Port Natal, are also tropical, *C. dilepis* from Gaboon and *C. nasutus* from Madagascar. At least a dozen species, in addition to *C. dilepis*, belong to western tropical Africa. Fernando Po has two peculiar species (*C. Burchellii* and *C. Owenii*) and one common to it and Old Calabar. The other western species are continental. *C. gracilis* has the greatest meridional range, extending from Senegal to Angola. South of the equator we also find *C. Capellii* from Benguela and *C. anchietæ* from Mossamedes. On this side of Africa the species seem more numerous north of the equator. The Camaroons yield *C. montium* (Figs. 4, 5) and *Rhampholeon*, the most aberrant of all the Chameleons. Lastly, *C. Brookesii* quits western Africa, reappearing in Madagascar!

From eastern tropical Africa we have four continental species, *C. lævigatus* from Khartoum, *C. affinis* from Abyssinia, *C. Petersii* from Mozambique, and *C. Melleri*. The first is, probably, further from the coast than any other tropical species. Of insular species, all south of the equator, twenty-one are peculiar, namely, from

Madagascar	15	species.
Madagascar and Bourbon	3	"
Madagascar, Bourbon, and Mauritius..	1	"
The Comoro Islands	1	"
The Seychelles	1	"

Madagascar has a total of twenty-one species; but two of these are also continental. According to Böttger, Chameleons make up one-fourth of the saurian fauna of this island, which we know to be equally peculiar as to its mammals. Five new species of Chameleons from Madagascar have been described by Dr. Günther since Böttger's estimate was made. In no other region is the genus Chameleon so conspicuously represented. It is curious, if true, that the tropical African mainland, nearest to Madagascar, should be poorer in species than the western coast. Is this due to its greater humidity,* or have we here to deal with an effect of migration, as in the case of the singular reptilian fauna of the Galapagos Islands?†

We find little or no mention of Chameleons frequenting central Africa properly so called.

Omitting the Cape species and dividing the Ethiopian region by its principal meridian, that of 20° E. longitude, we find only two species of Chameleons which live on both sides of this line.

The limited distribution of the Chameleons and the fact that none are known to be extinct‡ indicate the lateness of their origin. Pliny has called Africa the land of wonders in a sentence approvingly quoted by Linnæus. Professor Owen, who cites the same passage, has shown that its reptilian fauna in past times was no less wonderful than in the present.

We now return to the common and famous species, which also enjoys by far the widest range. It occurs in Spain (Andalusia), northern Africa, southern Africa, Asia Minor, the Indian Peninsula, and the northern parts of Ceylon. The British Museum contains specimens said to have been brought from Singapore and even Japan. Its presence in Ceylon has recently been denied, but the rebutting evidence on this point is indisputable. The occurrence of the Chameleon in Sicily has been asserted, denied, and reasserted.

Does the common Chameleon (like *C. Brookesii*) belong to the list of what Alphonse de Candolle has termed "disjointed" species? Thus, we find it recorded from northern and southern (but scarcely from intertropical) Africa. This alleged distribution plainly suggests that of the many African species one or more may be varieties of this common form. Have we not here a case somewhat similar to that offered in botany by the Cedar of Lebanon, with its western and eastern outliers, the Atlantic Cedar and the Deodara? Again, Dr. Gray cites no localities intermediate between Asia Minor and Hindostan. The Chameleon of our childhood, from "Arabia's wilds," as narrated in Merrick's poem, is not, according to Dr. Gray, the common form, but a distinct species, *C. auratus*. Such questions should not be undecided.

The Chameleon is often mentioned but little cared for by the vulgar, who regard the creature with the misplaced wonder of contented ignorance rather than with the intelligent curiosity which it deserves. It can barely be called a favorite, though among the cold-blooded vertebrates there is no other animal so well fitted to be made a household pet. Our knowledge of its structure and actions is still far from complete, yet very many naturalists have studied it. A long list of essays specially devoted to its elucidation might easily be cited; and many allusions are made to it in more general works, with titles which would scarcely lead us to expect such references. Two lines of inquiry need to be followed up, that we may trace what remains to be ascertained of the Chameleon's nature and history. First, its several parts, the eye only excepted, have not hitherto been minutely analyzed with those modern aids to research which are now so accessible. In the second place, the functions of its muscular and nervous systems have never been duly investigated by competent physiologists, availing themselves of the resources of experimental methods.§ Much might be learned in this way, even though we should curtail our studies from an unwillingness to subject the living animal to pain. Therefore, the life of the Chameleon, as contemplated by men of science, still remains in many respects a mystery.

The Chameleon may from time to time be bought and kept in captivity. Care should be taken to supply it with plenty of flies, crickets, or such other insects as can be had. (A fly-trap of honey or syrup may be used to save trouble.) It should be lodged in a properly ventilated glass case, some thirty inches in length, breadth, and height, furnished with a suitably branched shrub or fragment of a tree. A warm temperature should be maintained about it. Lastly, it should be allowed to relieve its thirst. The necessity of so doing is well shown by Brehm,‖ who carefully studied Chameleons when residing in Alexandria. He procured during the summer a large number of healthy specimens, more than a third of whom died after a fortnight's captivity. The remainder were very languid, of a dull uniform grayish yellow color, and careless of the food abundantly supplied them. Brehm now tried the experiment of treating his pets to an artificial shower of rain. Like magic, they revived. Their skin reassumed its more vivid and changing tints; they moved their sluggish limbs, going from leaf to leaf in quest of the grateful moisture, and, displaying with increased energy their insatiable greed for prey, soon appeared to be in better health than ever.

Those who have seen Chameleons in life would laugh at us for attempting to describe their form. Those who cannot view the living animal will learn more from the excellent (though uncolored) figure of a group of Chameleons in the work of Brehm than from any written description, or even, we might add, from the inspection of preserved specimens. We must, however, say something which may induce our readers to study these animals more closely, and we make, therefore, the following attempt to represent the Chameleon's most characteristic features:

The head is large, compared with the rest of the body, and though relatively short, is wide and very deep. In general form it is angular, with a high occipital crest, from the raised hinder apex of which a ridge-like wing descends on either side, then arches over each orbit, and finally stretches forward to meet its fellow just behind the rather blunt muzzle. The gape is very wide, the under jaw capacious. The nostrils lie far forwards, but are not very close. There are no external ears.

* "Zoological Society's Proceedings, 1874," p. 444 and Pl. lvii.

† In his "Catalogue of Lizards," published in 1845, only eighteen species of Chameleons are mentioned. See "P. Z. S., 1864," p. 465.

‡ "Descent of Man," vol. ii., 1871, p. 34.

* "P. Z. S., 1864." Pl. xxxii. It accompanies Dr. Gray's "Revision."

† Chameleons from Madagascar, described and figured by Dr. Gunther in "P. Z. S., 1879," Part I.

‡ Not including Northern (extra-tropical) Africa, which, with part of Asia and Southern Europe, belongs to the Mediterranean sub-region.

* For "west coast" read "east coast" in paragraph 275 of Sir John Herschel's article on "Physical Geography," in the last edition of the "Encyclopædia Britannica."

† See chap. xvii. of Darwin's "Naturalist's Voyage."

‡ We do not forget the fossil found at Wyoming, of which the following account has been published:

"Chamæleo Pristinus. Indicated by a lower jaw fragment containing eight teeth in a space of five lines. In every respect it agrees in character with the corresponding part in living species of the genus."

So noteworthy a conclusion as the existence of Chameleons in North America during Eocene times must rest on fuller evidence than this passage affords.

§ Some use, it is true, has been made of these methods in the study of the Chameleon's changes of color.

‖ See his "Thierleben," seventh volume of second edition, 1878.

The neck is short and stiff, appearing externally as little more than a fold between the head and the narrowed shoulders, from which the whole body slopes gradually backwards.

The trunk proper, compressed laterally, is singularly lean, and is sharpened along the middle line both of the back and belly, the ventral ridge being continued on the chin.

The tail also is much compressed, but is rounded beneath. It is prehensile, and usually twisted round some support. It constitutes more than half the total length of the animal, which is about ten inches.

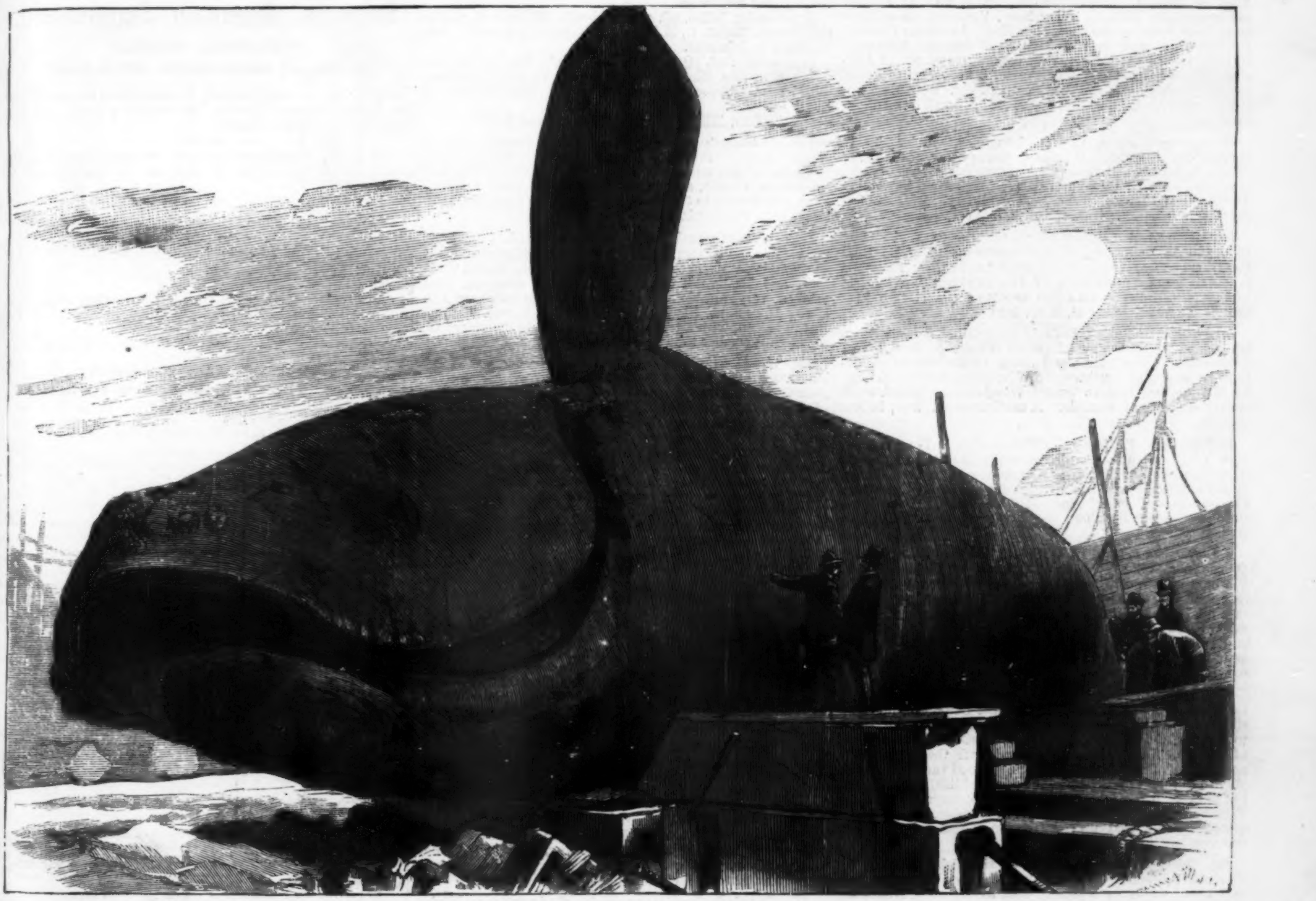
The slim nearly cylindrical limbs, not swollen in any part and much longer than the trunk, remind us of those of Cassius or Don Gonzales Pacheco. They end in hands and feet stouter than themselves, with their digits so arranged as to grasp securely the branches on which the animal rests. In each hand, the thumb, index and middle fingers, united by a membrane as far as their nails, are directed inwards; while the two other fingers, likewise united, are turned outwards. In each foot, the first and second toes are connected and turned inwards; they are opposed to the three outer toes, connected in the same way.

The Chameleon does not grovel like other reptiles. Its hips and shoulders are so disposed as to allow the limbs to sustain the trunk at a notable height above the branch which supports it.

(*To be continued.*)

THE CHARLESTON WHALE.

ON the morning of the 7th of January, 1880, a large whale was discovered in the harbor of Charleston, S. C., and a small fleet of three tugs, fifty to sixty row-boats, and numerous skiffs set out to capture the monster. Harpoons, lances, bullets, and like missiles were fired at or thrust into him all day long without any other effect but that of mutilating the animal most horribly. Finally, at sundown, a sailor fired at the animal and fortunately struck a vital part, causing the immediate death of the monster. The next day it was towed to Pregnall's Dock Railway and photographed there. In the annexed cut, which is taken from the *Leipziger Illustrirte Zeitung*, an exact copy of the photograph is given. The animal was 55 feet long, and its fat estimated to be worth from $600 to $800.



THE CHARLESTON WHALE.

TREE PLANTING.

THE *Lumberman* some weeks since published figures intending to show the enormous destruction of timber going on in the country, and ventured the assertion that the consumption of manufactured lumber in 1879 reached the very large amount of 17,500,000,000 feet, allowing but 350 feet as the individual average of consumption, which is an allowance of but 50 feet to the individual over the amount consumed in 1869, as shown by the census returns of 1870. Of this vast amount, our figures show that the single State of Michigan supplied last year 4,400,000,000 feet, or 25 per cent. of the entire estimated lumber consumption of the nation. Of course, these figures made no account of the timber cut for firewood, telegraph poles, railroad ties, staves, and the thousand and one purposes for which timber is used, and which, at an extremely low estimate, would double the amount of our estimate of manufactured lumber. If we take 40,000,000,000 superficial feet of timber as the actual consumption of the United States, we fancy that no well informed person will criticise the statement as being too high an estimate. If, then, the present population of the United States makes demand yearly for this vast amount of timber, a most pertinent question arises as to the source of supply in the near future. With an ever-increasing population demanding an ever-increasing volume of wood products, it is well worth our while to inquire where the future supplies are to come from.

In those sections of the country where all, or nearly all, varieties of timber are indigenous, and the ages have been occupied in producing the forests, it is but a usual phase of human nature that little value should be attached to the standing timber, and that the efforts of man should be pertinaciously put forth to destroy it. So far as this becomes requisite in the developing of a farming district, no fault can be found with it, yet the question still arises, in view of the fact that man cannot dispense with the use of timber, How shall it be replaced? It is a well known fact that many varieties of timber do not reproduce themselves upon the soil from which they have been taken. This is notably the case with pine timber. On the contrary, in some regions, as in New England, the chestnut lands reproduce the same timber, and may be cut over again in the course of fifteen or twenty years; and this process may be repeated in the rocky soil indefinitely.

As a rule, in the pine-producing districts of the Northwest, the second growth is of brambles or small poplar of value only in the manufacture of paper—the importance of which we would by no means underestimate—and other growths which are seldom of any worth even for firewood. It may be set down as a safe proposition that nine-tenths of the land once stripped of timber is not to be depended upon, either from natural tendency toward reproduction or the foresight of man, for renewing the waste which is in constant progress. The hope of the future generations upon the American continent must be in the now treeless prairies of the West, and in the foresight and care with which this and succeeding generations foster forest growths upon those vast expanses which can only be utilized for timber production by planting. There are but few sections of the prairie country which will not grow the larch, ash, catalpa, black cherry, ailantus, red maple, spruce, hemlock, red cedar, Scotch pine, and some other varieties of timber; and if only those varieties which are useful for railroad ties should be cultivated, the advantage to be derived from them in the years to come would be incalculable. The foresight of a settler at Fairbank, Minn., in planting trees upon a timberless farm, some years ago, has enabled him, within the past winter, to erect a barn upon his premises, constructed wholly from timber planted and cultivated by himself.

The new railroads built in the treeless States in 1879 required 10,000,000 ties in their construction, therefore, it will be seen what an immense consumption of forests is caused by railroads alone. Before the great panic of 1873, several attempts at tree planting had been made by railroad companies, but none were successful, owing to bad management, an improper selection of trees, neglect and fire, the result of the trees being planted too near the line of the rail roads; but, lately, an earnest has been given of the great value of the Harvard Arboretum at West Roxbury, Mass., to the material interests of the country. Within the last two years, under the inspiration of that institution, more systematic attempts at railroad tree planting have been made in Kansas by the Fort Scott and Gulf Railroad Company, several hundred acres having already been planted, and, during the present winter, a Boston capitalist has contracted for the planting of 560 acres of prairie land in Eastern Kansas. This plantation of 560 acres is to consist of 300 acres of the western catalpa, 200 acres of ailantus, and 60 acres which will serve as an experimental ground on which will be tested trees of several varieties, to be selected by the director of the Harvard Arboretum, Prof. Sargent. The western catalpa, a native of the lowlands bordering the lower Ohio and the banks of the Mississippi in Missouri, Kentucky, and Tennessee, is a rapidly growing tree, easily cultivated, and producing timber which, although soft, is almost indestructible when placed in the ground, and, therefore, of the greatest value for fence posts, railway ties, and similar uses. The ailantus will grow with great rapidity anywhere, where the climate is not too cold for it, and in spite of its wonderfully quick growth, produces hard heavy timber valuable for fuel, ties, cabinet work, or almost every purpose for which wood is used.

The importance of tree planting is now recognized by several of the Western States, which offer bounties for the best lots of woodland, and exempt land planted with trees from taxation for a considerable term of years. The Massachusetts Society for the Promotion of Agriculture offers fine premiums for the best acres of planted woodland of various kinds and stages of growth.

The Secretary of the Connecticut State Board of Education, Hon. B. G. Northrop, who is an enthusiastic arboriculturist, in stating that in Connecticut, in the last ten years, over $300,000 have been expended annually in building and repairing schoolhouses, says:

"Wise and necessary as was this expenditure, had one-hundredth part of this sum been spent annually in planting trees and adorning the school grounds, a still better result would have been accomplished in cultivating the taste of our youth, leading them to study and admire our noble trees, and realize that they are the grandest and most beautiful products of nature, and form the finest drapery that adorns this earth in all lands. Thus taught, they will wish to plant and protect trees, and find in their own happy experience that there is a peculiar pleasure in their parentage, whether forest, fruit, or ornamental—a pleasure that never cloys, but grows with their growth. Such offspring they will watch with pride, as every year new beauties appear. Like grateful children, they bring rich filial returns, and compensate a thousandfold for the trouble they cost. This love of trees early implanted in the school and fostered in the home will be sure to make our youth practical arborists."

If every farmer in this country would consider it a part of his routine work to plant annually 100 trees, the question of the future timber supply of the United States would be greatly simplified. The homestead laws of the United States wisely recognize, though not to as full an extent as would be desirable, the importance of renewing and maintaining the timber supply, by providing that the planting

and cultivating of one acre of timber in each forty shall be considered the full equivalent for clearing and cultivating, as required in those sections which are known as timber lands. The advantages will directly accrue to the owner of the land so improved, but indirectly to the country at large, in promoting greater rainfall, and in the recovery of vast tracts of now arid land, rendered so by the absence of trees. It will be well for the United States when a broad and catholic spirit shall prevail, which shall lead the owners of the soil to look forward to the needs of their children, and to the welfare of the millions who are to occupy the country in the remote as well as in the immediate future.—*N. W. Lumberman.*

[Continued from Supplement No. 232, page 3702.]

FOREST TREES OF NORTH AMERICA.

By Charles S. Sargent, Arnold Professor of Arboriculture in Harvard College, Special Agent Tenth Census.

226. *Quercus lyrata*, Walt. (Over-cup Oak. Swamp-Post Oak. Water-White Oak.) North Carolina and the valley of the lower Ohio; south to Florida, Arkansas (rare), and Eastern Texas. Wood moderately compact and resembling, though inferior to, that of *Q. alba*. A large tree; in deep and often submerged swamps. Not common.

227. *Quercus macrocarpa*, Michx. *Q. olivaformis*, Michx. *Q. macrocarpa*, var. *olivaformis*, Gray. (Burr Oak. Mossy-Cup White Oak. Over-cup Oak.) Canada and Northern Vermont, south to Lancaster County, Pennsylvania; west to Wisconsin, Eastern Nebraska, and Kansas. Wood probably of little value, except as fuel. A large tree, 60 to 80 feet in height, with a trunk 4 to over 8 feet in diameter. Not common east of the Alleghany Mountains.

228. *Quercus Muhlenbergii*, Engelm. Trans. St. Louis Acad. iii. 391. *Q. castanea*, Muhl. ap. Willd. *Q. Prinus*, var. *acuminata*, Michx. Perrysburg, Vermont, near Newburg, New York, on the Conestoga River, Lancaster County, Pennsylvania, and west to Eastern Nebraska, Arkansas, and the Indian Territory. Very common west of the Alleghany Mountains, and extending south to Western Florida and Mississippi. Wood compact, strong, very durable; largely used for railway ties, posts, etc. A small or medium-sized tree.

229. *Quercus nigra*, L. *Q. ferruginea*, Michx. f. *Q. quinqueloba*, Engelm. *Q. nigra*, var. *quinqueloba*, A.DC. (Black Jack Oak. Barren Oak.) Long Island, New York, south to Florida, and west to Eastern Nebraska, the Indian Territory, and Eastern Texas. A small tree, rarely exceeding 25 feet in height; in gravelly, barren soil.

230. *Quercus oblongifolia*, Torr. (Evergreen White Oak. Live Oak.) Mountains of Southwestern California, from San Diego to Los Angeles; and in Chihuahua. "The wood is said to be hard but brittle. A beautiful tree, 2 to 2½ feet in diameter (Brewer), with the aspect of the eastern Live Oak."—Engelm., Bot. Cal. ii. 97, ined.

231. *Quercus palustris*, DuRoi. (Pin Oak. Swamp Spanish Oak.) Western Massachusetts? (Emerson), New Haven, Connecticut, Long Island, and south to the District of Columbia; west and southwest to Wisconsin, Eastern Nebraska, Kansas, and Eastern Texas. Wood coarse-grained, moderately strong, not durable. A medium-sized tree; in low ground.

232. *Quercus Phellos*, L. (Willow Oak.) Long Island, New York, south to Florida, generally near the coast; and from Kentucky to Alabama, Arkansas, and Eastern Texas. Wood reddish, coarse-grained, not durable; sometimes used for the fellies of wheels, but of little value. A medium-sized tree; generally along the borders of swamps, in low, cool situations.

233. *Quercus Prinus*, L. *Q. Prinus*, var. *monticola*, Michx. *Q. montana*, Willd. (Chestnut Oak. Rock Chestnut Oak.) Vermont, shores of Lake Champlain, to the valley of the Genesee River, Livingston County, New York; south through the whole length of the Alleghany Mountains, and rarely eastward to the coast; in the mountains of Kentucky and Tennessee. Wood reddish, porous, strong, somewhat employed in construction, cooperage, etc., although inferior to white oak. A large or medium-sized tree.

234. *Quercus rubra*, L. (Red Oak.) Northern Nova Scotia, New Brunswick, valley of the St. Lawrence, northern shore of Lake Huron, western shore of Lake Superior, south to Florida, and Eastern Texas; the most widely distributed of the North American oaks, extending farther north than any species of the Atlantic forests. Wood varying remarkably in different localities: at the east, reddish, porous, light, not durable, principally employed in cooperage; in northern Wisconsin and Minnesota, heavier, durable, compact, and quite generally used in construction. A large tree. Very common in all rich woodlands.

235. *Quercus stellata*, Wang. *Q. obtusiloba*, Michx. *Q. Durandii?* Buckley. (Post Oak.) Martha's Vineyard, Massachusetts, south to Florida; west to Missouri, Nebraska, Kansas, and Eastern Texas. Wood resembling and probably equaling that of *Q. alba*. A small or medium-sized tree, rarely exceeding 50 feet in height.

236. *Quercus tinctoria*, Bartram. *Q. nigra*, Marsh [not L.] *Q. velutina*, Lam. *Q. coccinea*, var. *tinctoria*, Gray. (Black Oak. Yellow-barked Oak.) Canada and Northern New England, south to Tallapoosa County, Alabama and west to Wisconsin, Eastern Nebraska, and Eastern Kansas (rare). Wood close-grained, strong, durable, and probably superior to that of the other North American Black Oaks; employed in the manufacture of carriages, cooperage, construction, etc. A large tree, 80 to 100 feet in height, with a trunk often 4 to 5 feet in diameter; the bark rich in tannin; the intensely bitter inner bark yields a valuable yellow dye. Very common in all the Atlantic forests.

237. *Quercus undulata*, Torr. (Rocky Mountain Scrub Oak.) Eastern slope of the Rocky Mountains of Colorado from Denver southward, through New Mexico into Western Texas; west through Utah and Arizona into Southern California. A small tree, or often a shrub running into innumerable forms, of which the best marked are:

Var. Gambelii, Engelm. (*Q. Gambelii*, Nutt, and *Q. Drummondii*, Liebm.)

Var. Jamesii, Engelm.

Var. Wrightii, Engelm.

Var. breviloba, Engelm (*Q. obtusiloba*, var. *breviloba*, Torr.; *Q. San Sabeana*, Buckley?)

Var. oblongata, Engelm. (*Q. oblongifolia*, Torr. in Bot. Mex. Bound. 206—not Bot. Sitgr.)

Var. grisea, Engelm. (*Q. grisea*, Liebm.)

Var. pungens, Engelm. (*Q. pungens*, Liebm.)

See Engelman in Trans. St. Louis Acad. iii. 372, 382, 392, and Bot. Cal. ii. 96, ined.

238. *Quercus virens*, Ait. *Q. sempervirens*, Ait. *Q. oleoides*, Cham. and Schl. *Q. retusa*, Liebm. (Live Oak.) Mob Jack Bay, Virginia, south to Florida, near the coast; west along the Gulf coast to Mexico; in Texas penetrating to the high plateau north of San Antonio (Engelmann in Pl. Lindh. ii. 237), where it might, without fruit, be easily confounded with *Q. Emoryi*. Wood yellowish, very heavy, compact, fine grained, strong, and durable; largely employed in ship-building, for which purpose it is preferred to all other North American woods. A tree 50 to 60 feet in height, with a trunk 4 to 7 feet in diameter; of the first economic value; or reduced to a shrub (Var. *maritima* and *dentata*, Chapman; *Q. maritima* Willd.); the bark rich in tannin.

239. *Quercus Wislizeni*, A.DC. *Q. Morehus*, Kellogg. California, "common in the valleys and in the lower mountains throughout the State, and ascending into the Sierra Nevada." The variety (Var. *frutescens*, Engelm.) is the "Desert Oak" of the southeastern desert region, ranging northward to Mount Shasta. "A magnificent tree, with very dense dark-green and shining foliage; sometimes 10 to 12 and even 18 feet in circumference (Shasta—Brewer), and 50 to 60 feet high."—Engelm. in Bot. Cal. ii. 98, ined.

The following North American shrubby species do not properly find a place in this catalogue:

Q. Breweri, Engelm. in Bot. Cal. ii. 96, ined. (*Q. lobata*, var. *fruticosa*, Engelm.) Western slopes of high Sierra Nevada, California.

Q. Georgiana, M. A. Curtis. Stone Mountain, Georgia.

Q. myrtifolia, Willd. (*Q. Phellos*, var. *arenaria*, Chapman.) *Q. aquatica* var. *myrtifolia*, A.DC. Sea coast, South Carolina to Florida.

Q. ilicifolia, Wang. (*Q. Banisteri*, Michx.) New England to Ohio and southward.

Q. prinoides, Willd. (*Q. prinus pumila*, Michx.; *Q. prinus chinquapin*, Michx. f., A.DC.; *Q. chinquapin*, Pursh.) New England to Arkansas.

Q. pumila, Nutt. (*Q. Phellos*, var. *pumila*, Michx.; *Q. cinerea*, var. *pumila*, Chap.) and var. *sericea*, Engelm (*Q. sericea*, Willd.; *P. Phellos*, var. *sericea*, Ait.). Pine barrens of South Carolina.

Q. reticulata, HBK. Southern Arizona and Mexico.

240. *Castanopsis chrysophylla*, A.DC. *Castanea chrysophylla*, Hook. *C. sempervirens*, Kellogg. (Chinquapin.) Western Oregon and California, along the western flank of the Sierra Nevada, and in the coast ranges south to Santa Cruz. A tree 30 to 50 feet in height, in the Cascade Mountains, or in California often a low shrub.

241. *Castanea pumila*, Mill. *Fagus pumila*, L. (Chinquapin.) Lancaster County, Pennsylvania; Marietta, Ohio; south and southwest to Florida, Arkansas, the Indian Territory, and Eastern Texas. Wood strong, compact, even grained, very durable. A shrub or, in the southern Alleghany Mountains, Florida, and Arkansas, a tree 30 to 50 feet in height, with a trunk often 18 inches in diameter; the sweet fruit smaller than that of the next species.

242. *Castanea vulgaris*, Lam. var. *Americana*, A.DC. Prodr. xvi.[2] 114. *Fagus Castanea*, L. *C. vesca*, Gærtn, var. *Americana*, Michx. *C. Americana*, Raf. Northern shores of Lakes Erie and Ontario, Southern Maine, New Hampshire, and Vermont; south to Western Florida, and west and southwest to Michigan and Arkansas; reaching its greatest development in Tennessee, along the western slopes of the Alleghany Mountains. Wood light colored, coarse-grained, moderately strong, very durable, but difficult to season, and liable to warp; largely employed in cabinet making, and for railway ties, posts, fencing, etc. A large tree; of the first economic value; the fruit, although smaller, superior in sweetness and flavor to that of the European chestnut.

243. *Fagus ferruginea*, Ait. *Fagus sylvestris*, Michx. (American Beech.) Nova Scotia and New Brunswick, through the valley of the Saint Lawrence and Ottawa Rivers, and the northern shores of Lakes Huron and Michigan to Missouri and Minnesota; south to Florida and Arkansas. Wood light-colored or reddish, varying greatly with soil and location, close-grained, compact, heavy, and susceptible of a beautiful polish; employed in the manufacture of shoe-lasts, handles of tools, and in turnery; used largely as fuel. A large tree. Very common in all northern forests east of the Mississippi River, and in those of the southern Alleghany Mountains.

244. *Ostrya Virginica*, Willd. *Carpinus Ostrya*, L. *Carpinus Virginiana*, Lam. *O. Americana*, Michx. *O. vulgaris*, Watson. *Carpinus triflora*, Mœnch. Nova Scotia, New Brunswick, through the valleys of the St. Lawrence and the lower Ottawa Rivers, along the northern shores of Lake Huron, to Northern Wisconsin; south to Florida, and west to Fremont County, Iowa, Missouri, and Arkansas. Wood white, compact, fine-grained, very heavy, durable. A small tree, rarely exceeding 40 feet in height, or with a trunk more than 12 to 15 inches in diameter.

245. *Carpinus Caroliniana*, Walt. *C. Americana*, Michx. (American Hornbeam. Blue Beech. Water Beech. Iron Wood.) Northern Nova Scotia and New Brunswick, through the valley of the St. Lawrence and lower Ottawa Rivers, along the northern shores of Lake Huron to Northern Wisconsin and Minnesota; south to Florida and Eastern Texas. Wood resembling that of Ostrya. At the North generally a shrub or small tree, but becoming, in the southern Alleghany Mountains, a tree sometimes 50 feet in height, with a trunk 2 to 3 feet in diameter.

BETULACEÆ.

246. *Betula alba*, L. var. *populifolia*, Spach. *B. populifolia*, Willd. *B. acuminata*, Ehrh. *B. cuspidata*, Schrad. (White Birch. Old Field Birch. Gray Birch.) New Brunswick, and from the valley of the lower Saint Lawrence River south to Delaware, near the coast. Wood white, moderately hard, close-grained, susceptible of a good polish; extensively manufactured into spools, shoe-pegs, etc., and recently largely exported. A small tree, rarely exceeding 20 to 30 feet in height; in dry and gravelly soil, or on the borders of swamps; springing up everywhere on abandoned land in New England.

247. *Betula lenta*, L. *B. carpinifolia*, Ehrh. *B. lenta*, Regel in DC. Prodr. xvi.[2] 179, in part. (Cherry Birch. Black Birch. Sweet Birch. Mahogany Birch.) Nova Scotia, Canada, and through the Northern States; west to Illinois, and south along the Alleghany Mountains to Georgia. Wood reddish, close-grained, compact, moderately hard, susceptible of a brilliant polish; furnishing a valuable material for cabinet-making, and excellent fuel. A medium-sized tree. Common at the North in rich woodlands.

248. *Betula lutea*, Michx. f. *B. excelsa*, Pursh. [not Ait.] *B. lenta*, Regel in DC. Prodr. xvi.[2] 179, in part. (Yellow Birch. Gray Birch.) Newfoundland to the western shore of Lake Superior, through the New England and Northwestern States, and south along the Alleghany Mountains to the high peaks of North Carolina. Wood resembling, and perhaps surpassing, that of the last species. The largest deciduous tree of the forests of Canada and Northern New England, not rarely 80 feet in height, with a trunk 3 to 4 feet in diameter.

249. *Betula nigra*, L. (Red Birch. River Birch.) Banks of the Merrimac and Spicket Rivers, in Middlesex and Essex Counties, Massachusetts, and from New Jersey south to Florida and Tallapoosa County, Alabama; west to Missouri, Arkansas, and Eastern Texas. A medium-sized tree; along the borders of streams and ponds.

250. *Betula occidentalis*, Hook. California, "in the eastern cañons of the Sierra Nevada, above Owen's Valley, at an altitude of from 4,500 to 10,000 feet, where it is reported as abundant and often the main reliance of the settlers for timber for fencing and other purposes; Surprise Valley, Modoc County (Lemmon), and common along streams in Siskiyou County, where it is known as 'Black Birch.' It is frequent from Washington Territory to the Saskatchewan and in the Rocky Mountains to New Mexico."—Watson, Bot. Cal. ii. 79, ined.

(*To be continued.*)

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